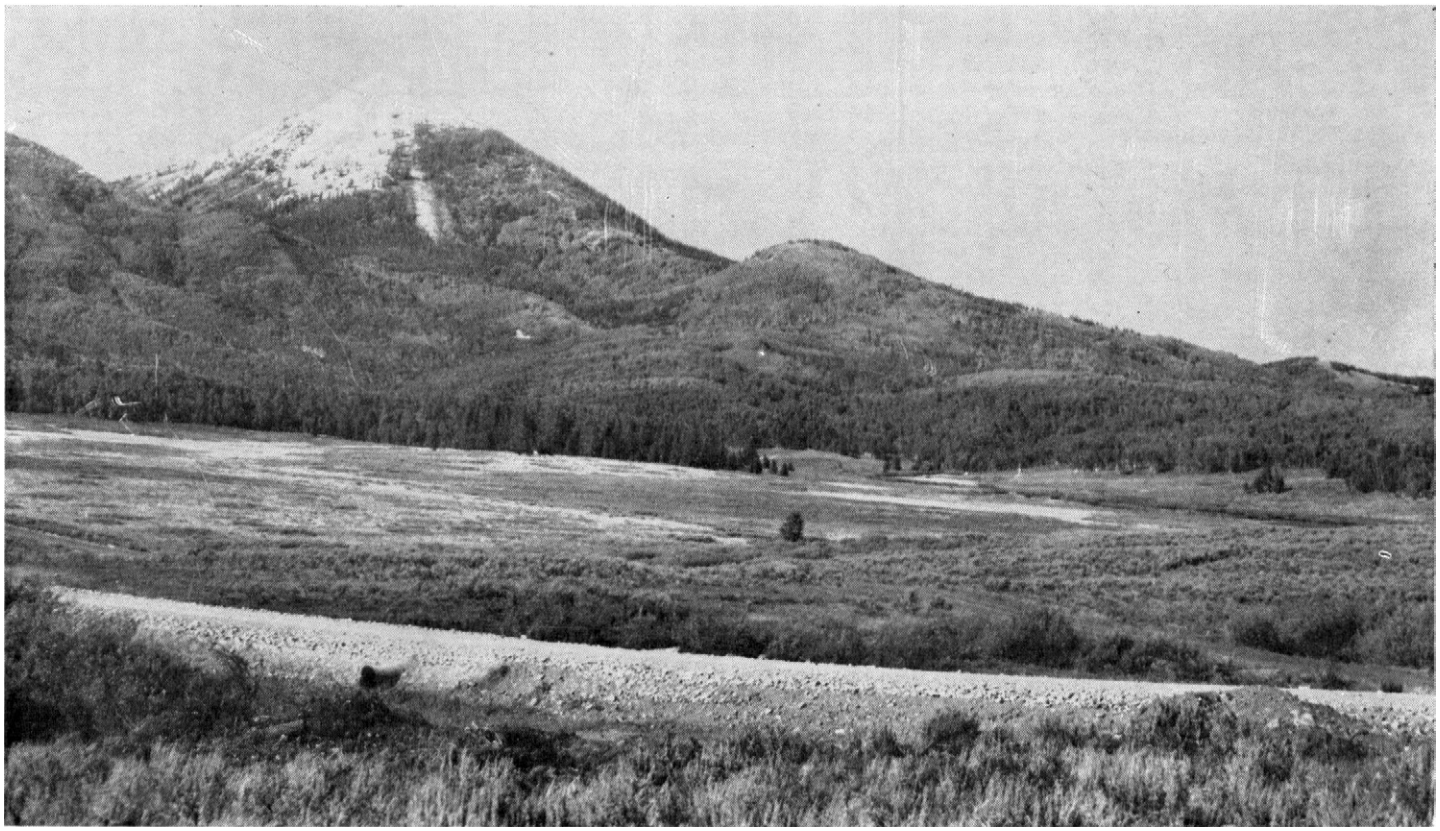
SOIL SURVEY

Trout Creek Watershed Colorado



UNITED STATES DEPARTMENT OF AGRICULTURE
Forest Service and Soil Conservation Service
in cooperation with
COLORADO AGRICULTURAL EXPERIMENT STATION

Series 1958, No. 5

Issued May 1961

TROUT CREEK WATERSHED is a rough, mountainous area that receives little rainfall and has a short growing season. It has never been used for general farming but has remained in timber and grass. Because of improper use of the land, much of the area has been seriously damaged by erosion and gullying. Much of this damage was done during the early development of the region, about 1860, when mining, destructive logging, and excessive use of the range were common and accepted practices.

This soil survey was made to obtain basic information that will help in developing a multiple-use management plan for the watershed. The objectives of management are to stop soil deterioration, to increase sustained yields of water, to provide maximum yields of timber and herbage, and to increase wildlife and recreational values. The possibilities for the production of timber and forage are limited, but the watershed can be improved as an environment for wildlife and made more attractive as a recreational area.

Part I of this report gives general information about the people and their use of the land, physiography, rock formations, climate, vegetation, and wildlife. Part II consists of descriptions of the various kinds of soils in the watershed. Part III deals with the use and management of the soils.

The map at the back of the report shows the location and distribution of the soils. Each soil is identified on the map by a symbol. An index to the map sheets is supplied, to show what part of the surveyed area is represented on each of the numbered map sheets.

Fieldwork for this survey was completed in 1956. Unless otherwise specified, all statements in the report refer to conditions at that time.

U.S. GOVERNMENT PRINTING OFFICE: 1961

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

Contents

Series 1958, No. 5. Issued May 1961

SOIL SURVEY OF TROUT CREEK WATERSHED, COLORADO

SURVEY BY J. L. RETZER, IN CHARGE, C. J. FOX, J. Y. NISHIMURA, AND D. V. HARRIS, FOREST SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH COLORADO AGRICULTURAL EXPERIMENT STATION

Part I: The Landscape

Trout Creek Watershed is part of the Upper Arkansas River basin. It is in the central part of Colorado, at the northeastern edge of Chaffee County (fig. 1). It is about 8 miles east of Buena Vista, 26 miles north of Salida, and 85 miles southwest of Denver. The principal highway is U. S. Highway No. 24–285. The northern, northeastern, and eastern rims of the Trout Creek drainage form part of the boundary between Chaffee and Park Counties. The area of the watershed is 58.5 square miles, or approximately 37,409 acres.

Almost all of the watershed is in the Salida Ranger District of the San Isabel National Forest. Some of the surveyed area is outside the boundaries of the national forest. Of the area within the national forest, 82 percent is owned by the Federal Government, 11 percent by the State of Colorado, and the rest by private owners. Much of Chubbs Park is State owned. A substantial acreage in Chubbs Gulch is privately owned also, as are scattered tracts in Mushroom Gulch, in Castlerock Gulch, in Bassam Park, and along Trout Creek.

People and Their Use of the Land

About 1860 Trout Creek Pass began to be heavily used by miners, cattlemen, and settlers as they moved from the high, level land of South Park to the mining areas along the upper Arkansas River and the extensive ranching lands farther west in Colorado. In these early days heavy damage was done by excessive grazing and destructive logging. The number of sheep, cattle, and horses was uncontrolled. Much timber was removed for mine props, charcoal, railroad ties, and piling. Fires were numerous and uncontrolled, since loggers desired only dead timber and frequently deliberately set fires ahead of their logging operations.

Around the turn of the century, other routes and passes were opened through the mountains, and the use of this area began to taper off somewhat.

The watershed became part of the Leadville National Forest in 1905. Through consolidations, the present boundaries that encompass Trout Creek Watershed were established in 1944, and the area is now a part of the San Isabel National Forest.

Measures to check erosion and prevent further deterioration of the watershed began in 1932. These first efforts were followed by additional rehabilitation work beginning in 1955 and continuing through the present. Rehabilitation efforts have been concerned with the development of erosion control and stabilization structures, range reseeding, tree planting, and reduction of grazing and logging.

Although it is difficult to visualize what the original condition of the watershed may have been, a study of the soils as they exist today indicates that the watershed as a whole has limited potential for commercial timber growing and for livestock grazing. It is true that certain soils in the area have high value for timber and range forage, but the acreage of these soils is small. Some portions of the watershed have a high potential for wildlife, particularly as winter habitats for deer and elk. Fishing at present is of minor importance, but it can be expected to improve under proper land management. The transcontinental highway that traverses the area presents an opportunity for more intensive recreational use and management. It can be expected that the improved program of land use will result in an increased sustained water yield.

Physiography, Relief, and Drainage

Trout Creek Watershed lies in the Southern Rocky Mountain physiographic province, between the Mosquito Range and the Arkansas Hills (*3*).[1] It includes a number of minor drainages that are part of the Upper Arkansas Valley. Trout Creek is a tributary of the Arkansas River.

Narrow stream bottoms, small valleys, steep ridges, high escarpments, hilltops, and mesas with steep sides and undulating to rolling tops characterize the topography of Trout Creek Watershed. The main valleys are along fault lines. In the northern part of the watershed, an escarpment formed of resistant limestone, dolomite, and sand-

[1] Italic numbers in parentheses refer to Literature Cited, p. 47.

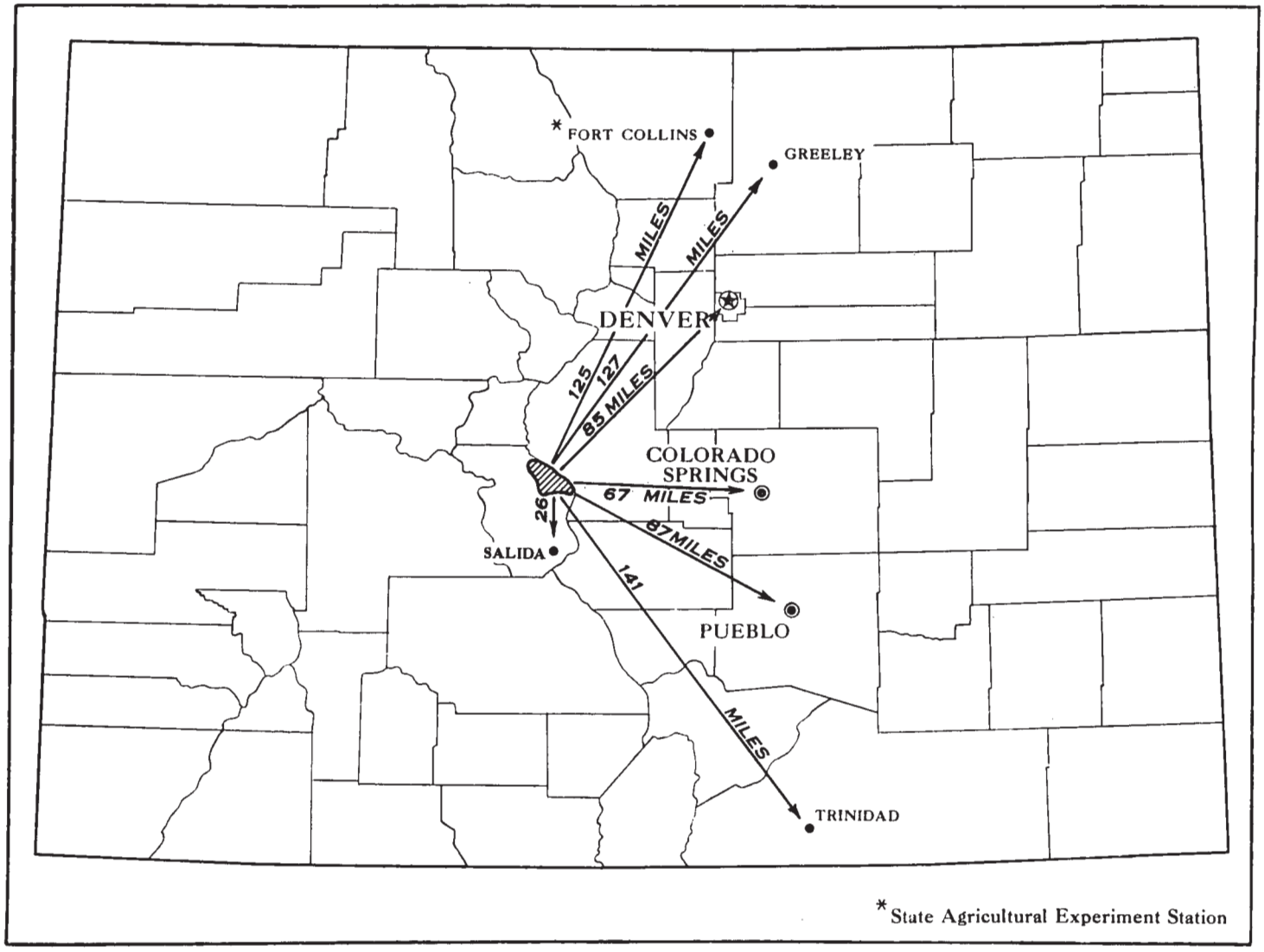

Figure 1.—**Location of Trout Creek Watershed in Colorado.**

stone overlooks a small valley underlain by shale and siltstone. The shale and siltstone are less resistant to weathering and have eroded to form drainageways separated by low ridges of more resistant sandstone. In the southern part of the watershed, extrusive igneous rock has formed many escarpments and steep mesa rims. In the central part, moderately steep to steep, rocky mountains extend from the west to the east boundary. Large outcrops of weatherworn granite are common in this section.

The highest point in the watershed—10,830 feet—is at the top of the drainage above Chubbs Gulch, between Chaffee and Park Counties. At Trout Creek Pass, the elevation is 9,487 feet, and the adjoining ridges rise to an elevation of 10,528 feet. Along Trout Creek and its small tributaries, the elevation is generally between 8,410 and 9,750 feet. The difference in elevation between the streams and the adjacent hills and ridges ranges from 300 feet in the northern part of the watershed to 950 feet at the point where Trout Creek leaves the watershed.

Surface drainage is generally rapid because the slopes are very steep and the soils are shallow. Only the bottom lands and small areas on mesa tops have slow surface drainage.

Peak flows occur early in spring and after heavy thunderstorms. Flash floods produced by thunderstorms are fairly common. The stream channel below Chubbs Gulch is about the only part of Trout Creek that flows permanently. A free-flowing spring, just above the bridge on U.S. Highway No. 24-285, is a constant source of water for Trout Creek. Nearly all of the other streams are intermittent or subterranean. Generally, surface flow ceases during the driest part of the year.

In areas underlain by limestone, the drainage pattern is coarse textured and of the lattice type; in areas underlain by shale, sandstone, and granite, the pattern is fine textured and dendritic. In areas that have been covered by lava, the drainage system is very poorly developed. On steep slopes along the main streams and gulches, short rills and gullies have formed. Most of these are not natural drainageways but are the results of misuse.

The density of the drainage pattern is related to slope,

permeability, water-holding capacity, and other soil characteristics. Soils that have steep slopes and low water-holding capacity have heavy, rapid runoff that concentrates and cuts many drainage channels; consequently, a fine-textured drainage pattern develops. On soils that have gentler slopes and greater water-holding capacity, runoff is slower and the drainage pattern is coarser textured.

Climate

The climate of the watershed is variable because of the diversified topography. Annual precipitation varies from 9.28 inches at the lowest elevations to 20 inches in a few places at the highest elevations. Cloudbursts during which 1 to 2 inches of rain falls in an hour are not uncommon. Such storms have serious consequences, because they frequently come at the end of rainy spells when the soil is already saturated.

Normally, the early part of spring is wet and the period from May 31 to the middle of July is dry and windy. In August there is generally sufficient rain, including some cloudbursts. A second dry period begins at the end of August and lasts till the end of November; sometimes a little rain or snow falls in September or October.

Temperature and precipitation data recorded at Buena Vista, just west of the surveyed area, are given in table 1. The average length of the growing season at Buena Vista is 104 days. The average date of the last killing frost in spring is June 8; the latest recorded was on June 28. The average date of the first killing frost in fall is September 20; the earliest recorded was on August 29.

Temperature and precipitation data for the surveyed area are not available, and observations indicate that the records at Buena Vista are not directly applicable. Owing to differences in altitude and aspect, temperature and precipitation within the watershed vary greatly within short distances. Differences are due primarily to differences in altitude. At altitudes of more than 9,000 feet, frost may be expected in any month of the year. For the greater portion of the surveyed area, a growing season of 80 to 100 days is more likely than the 104 days that is average at Buena Vista. Average temperatures differ so greatly within such short distances that their evaluation is impossible with the limited data available. Northerly exposures are cooler than southerly exposures, and temperatures decrease with increasing altitude. Other factors affect the temperatures, and a wide variety of microclimates exists.

Vegetation

Trout Creek Watershed is characteristic of the lower ponderosa pine zone of the Colorado Front Range of the Rocky Mountains. The vegetation includes many kinds of trees, shrubs, grasses, and other plants. Originally, most of the area was covered by a forest that probably was composed of the same species as the present forest but in different proportions. Cutting and burning have altered both the forest and the grass cover. At present there are only small, scattered areas of commercial timber, and the rangeland, because of heavy use, is eroded and has lost the more desirable range plants.

TABLE 1.—*Temperature and precipitation at Buena Vista Station, Chaffee Co., Colo.*

[Elevation, 8,020 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1939)	Wettest year (1906)	Average snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	23.8	77	−31	0.39	0.19	0.23	4.6
January	22.9	71	−37	.36	.04	.76	5.6
February	26.8	67	−31	.58	.16	[3]	7.4
Winter	24.5	77	−37	1.33	.39	.99	17.6
March	33.3	68	−30	.72	.80	2.15	7.7
April	40.0	89	−6	.89	0	2.50	6.6
May	48.6	92	6	.83	[3]	.02	2.0
Spring	40.6	92	−30	2.44	.80	4.67	16.3
June	56.6	105	21	.56	0	.07	.3
July	61.2	102	25	1.81	.20	2.97	0
August	59.7	94	25	1.33	[3]	1.82	0
Summer	59.1	105	21	3.70	.20	4.86	.3
September	53.6	95	15	.72	.30	3.01	.4
October	44.3	82	−2	.64	[3]	1.59	2.9
November	32.4	72	−23	.45	[3]	.65	4.9
Fall	43.4	95	−23	1.81	.30	5.25	8.2
Year	41.9	105	−37	9.28	1.69	15.77	42.4

[1] Average temperature based on a 46-year record, through 1955; highest temperature on a 42-year record and lowest temperature on a 40-year record, through 1952.

[2] Average precipitation based on a 55-year record, through 1955; wettest and driest years based on a 47-year record, in the period 1900-1955; snowfall based on a 45-year record, through 1952.

[3] Trace.

Three types of vegetative cover are recognized in the watershed. Each type is associated with particular soils and with a particular range in altitude and in amount of rainfall (table 2).

1. The pinyon-juniper type is in a low-rainfall area of Stecum soils (fig. 2), which are on steep south- and west-

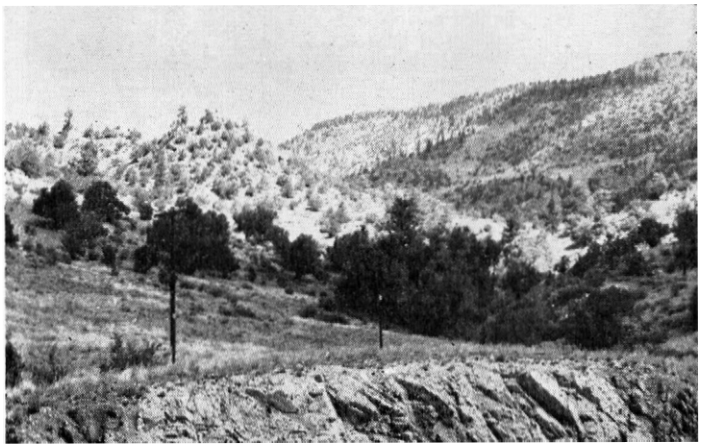

Figure 2.—Sparse cover of pinyon and juniper on Stecum soils.

TABLE 2.—*Soil series, vegetation types, and range in elevation and precipitation*

Soil series and associated vegetation type	Approximate annual rainfall	Approximate altitude	Characteristics of vegetation	
			Aspect	Typical plants
Pinyon-juniper.	*Inches*	*Feet*		
Stecum	9 to 14	8, 400 to 9, 900	Open forest	Pinyon, juniper, ring muhly, blue grama, sagebrush, and fescue.
Coniferous forest.				
Chubbs	12 to 20	9, 600 to 10, 500	Forest	Spruce, Douglas-fir, and aspen; thin to moderate understory of grass and shrubs.
Edloe	12 to 14	8, 900 to 9, 900	Forest	Spruce, Douglas-fir, and scattered aspen; understory of brush and grass.
Trout Creek	12 to 14	9, 100 to 9, 600	Forest	Spruce, aspen, and ponderosa pine; relatively thick understory of brush and grass.
Mountain bunchgrass.				
Bassel	9 to 14	8, 400 to 9, 200	Range	Ring muhly, blue grama, rabbitbrush, and winterfat; scattered pinyon.
Buena Vista	12 to 14	8, 900 to 9, 500	Range	Ring muhly, blue grama, sagebrush, fescue, and weeds; scattered patches of aspen and scattered ponderosa pine.
Garo	12 to 14	9, 100 to 9, 600	Range	Western wheatgrass, snakeweed, ring muhly, and fescue.
Heath	12 to 14	9, 100 to 9, 600	Range	Ring muhly, fescue, western wheatgrass, fringed sage, and pingue.
Laporte, Nathrop, and Trump.	12 to 14	9, 600 to 10, 000	Range and open forest	Scattered pine and spruce; understory of fescue, muhly, needle-and-thread, and pingue.
Wellsville	12 to 14	9, 000 to 9, 500	Range	Muhly, fescue, and cacti; scattered pinyon and juniper.

facing mountainsides. The soils on these slopes are warmer and drier than the soils on north- and east-facing slopes. The understory, where present, generally consists of a sparse growth of ring muhly, blue grama, Indian ricegrass, fescue, and sagebrush.

2. A coniferous forest grows on the north- and east-facing slopes at elevations of 8,900 to 10,500 feet (fig. 3). Chubbs, Edloe, and Trout Creek soils support lodgepole pine, spruce, Douglas-fir, ponderosa pine, and aspen; however, the composition, quality, and density of the stand and the character of the understory is different for each soil. Open grassy areas are common.

Both the pinyon-juniper and the coniferous forest extend over some miscellaneous land types. Scattered trees grow on Rock land. These sparsely timbered areas are on shady slopes below mesa rims and escarpments.

***Figure 3.*—Coniferous forest on east-facing slopes. Mountain bunchgrass in foreground.**

3. The mountain bunchgrass type is found in open parks and on south-facing slopes of the Laporte, Nathrop, Trump, Garo, Heath, Buena Vista, Bassel, and Wellsville soils. A cover of Arizona fescue, Thurber's fescue, various species of muhly, big sagebrush, fringed sagebrush, and widely scattered pinyon and juniper trees is common. There is some timber danthonia, needle-and-thread, winterfat, and pingue in places. Scattered ponderosa pines are common on the Buena Vista soils. Silver sagebrush and shrubby cinquefoil are common in the moister sites. In overgrazed and eroded areas there is a high percentage of western wheatgrass, ring muhly, blue grama, broom snakeweed, rabbitbrush, and big sagebrush.

The scientific and common names of the principal native and exotic plants in the watershed are listed below:

TREES

Scientific Names	*Common Names*
Juniperus scopulorum	Juniper.
Picea engelmanni	Engelmann spruce.
P. pungens	Blue spruce.
Pinus aristata	Bristlecone pine.
P. contorta var. *latifolia*	Lodgepole pine.
P. edulis	Pinyon.
P. ponderosa	Ponderosa pine.
Populus angustifolia	Cottonwood.
P. tremuloides	Quaking aspen.
Pseudotsuga taxifolia	Douglas-fir.

SHRUBS

Acer glabrum var. *neomexicanum*	Mountain-maple.
Arctostaphylos uva-ursi	Kinnikinnick.
Artemisia cana	Silver sagebrush.
A. frigida	Fringed sagebrush.
A. tridentata	Big sagebrush.
Caragana arborescens	Siberian pea tree.
Ceanothus americanus	Jerseytea.
Cercocarpus montanus	Mountain-mahogany.

SHRUBS—Continued

Scientific Names	*Common Names*
Crataegus spp	Hawthorn.
Chrysothamnus spp	Rabbitbrush.
Elaeagnus commutata	Silverberry.
E. angustifolia	Russian-olive.
Eurotia lanata	Winterfat.
Gutierrezia sarothrae	Broom snakeweed.
Juniperus communis	Prostrate juniper.
Potentilla fruticosa	Shrubby cinquefoil.
Prunus pensylvanica	Pin cherry.
P. pumila	Sand cherry.
P. virginiana	Chokecherry.
Purshia tridentata	Bitterbrush.
Quercus gambelii	Oak brush.
Ribes spp	Currant.
Rosa spp	Wild rose.
Rubus spp	Trailing raspberry or blackberry.
Salix spp	Willow.
Symphoricarpos albus	Snowberry.
Thermopsis montana	Mountain thermopsis.
T. rhombifolia	Goldenpea.

FORBS AND GRASSES

Hymenorys richardsoni	Pingue.
Agoseris spp	Mountain dandelion.
Agropyron smithii	Western wheatgrass.
Aquilegia coerulea	Colorado columbine.
Arestida spp	Three-awn grass.
Bouteloua gracilis	Blue grama.
Bromus anomalus	Nodding brome.
B. carinatus	Mountain brome.
Carex spp	Sedge.
Cystopteris fragilis	Ferns.
Danthonia intermedia	Timber oatgrass.
D. parryi	Parry danthonia.
Delphinium spp	Larkspur.
Festuca arizonica	Arizona fescue.
F. thurberi	Thurber's fescue.
Fragaria spp	Strawberry.
Geum spp	Avens.
Gutierrezia sarothrae	Broom snakeweed.
Hordeum jubatum	Foxtail barley.
Juncus spp	Rush.
Koeleria cristata	Junegrass.
Lathyrus spp	Peavine.
Linum spp	Flax.
Lupinus spp	Lupine.
Mertensia spp	Bluebells.
Muhlenbergia filiculmis	Slimstem muhly.
M. montana	Mountain muhly.
M. richardsonis	Mat muhly.
M. torreyi	Ring muhly.
M. wrightii	Spike muhly.
Opuntia spp	Pricklypear.
Oryzopsis hymenoides	Indian ricegrass.
Poa	Bluegrass.
Sitanion spp	Squirreltail.
Stipa comata	Needle-and-thread.
Yucca glauca	Yucca.

Wildlife

Mule deer are the most numerous of the big-game animals, but elk, mountain sheep, and black bear are found occasionally. Beavers have occupied extensive sections of the streams, and porcupines are found in most parts of the watershed. Mice, gophers, Wyoming ground squirrels, prairie dogs, chipmunks, rabbits, shrews, weasels, badgers, skunks, minks, bobcats, and chickarees are also found on this drainage.[2]

There are few fish in Trout Creek. Although in recent years the stream has been improved as a habitat for fish, its fish-producing potential appears to be small because of the size and extent of the stream.[3]

The only game birds are blue grouse and ducks. Nongame birds are numerous in the uplands.

Part II: The Soils

To get the basic information that is in this report, soil scientists examined the soils in the field to determine the characteristics of the surface soil, subsoil, and substratum, and then plotted the extent of each kind of soil on an aerial photograph. On the basis of facts determined in the course of the field survey and of data obtained by physical and chemical analyses in the laboratory, the soils were then classified into orders, great soil groups, series, types, and phases (see Glossary).

This part of the report consists of descriptions of all the soils mapped in Trout Creek Watershed; a discussion of soil formation; descriptions of the soil materials and soil-forming factors; and technical descriptions of representative soil profiles for each series.

Descriptions of Mapping Units

Soil phases, soil types, complexes, and miscellaneous land types (see Glossary) were mapped in Trout Creek Watershed. Each unit is described individually in the following pages. Each description includes the alphabetic symbol that identifies the mapping unit on the soil map. The acreage and proportionate extent of each mapping unit are given in table 3.

Each description includes a subsection on use and suitability. This is a brief discussion of the present uses of the soils and an evaluation of relative suitability for different uses. The evaluation is based on the characteristics of the soil and represents the best knowledge available at the time. No management decisions are intended or implied.

Alluvial land (Av).—This is a miscellaneous land type that occupies long, narrow bands on the flood plains of streams and minor drainageways. It is associated with most of the major soils in the watershed. It consists of recent accumulations of sediments derived from a variety of rocks and upland soils. Some of the sediments have been carried a considerable distance by streams, sorted to some extent according to size of particles, and redeposited along the stream courses. Others, of local origin, have been washed but short distances and deposited in minor drainageways. The areas adjacent to major drainageways are subject to flooding and deposition of new sediments. Most of the drainageways are deep; consequently, much of the acreage is well drained and, in places, a very weak subsoil has developed. The relief is nearly level to gently sloping. The slopes generally do not exceed 4 percent.

The present vegetation is mainly grass; it includes blue grama, Western wheatgrass, Arizona fescue, Thurber's fescue, and other species. Fringed sagebrush is abundant, and shrubby cinquefoil is a common shrub. In spots that

[2] Information furnished by the Division of Range and Wildlife Management, U. S. Forest Service, Region 2, Denver, Colorado.

[3] HOWARD A. TANNER, Report of Field Investigation Trip to Trout Creek Watershed, December 1, 1955.

TABLE 3.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Alluvial land	3, 369	9. 0
Bassel sandy loam	226	. 6
Bassel sandy loam, severely eroded	173	. 5
Buena Vista very stony sandy loam	862	2. 3
Buena Vista very stony sandy loam, eroded	845	2. 3
Buena Vista very stony sandy loam, severely eroded	109	. 3
Chubbs clay loam	3, 466	9. 3
Edloe gravelly sandy loam	2, 706	7. 2
Garo clay loam	438	1. 2
Garo clay loam, severely eroded	1, 280	3. 4
Heath clay loam, eroded	199	. 5
Heath loam and clay loam	1, 187	3. 2
Laporte-Nathrop-Trump complex	1, 983	5. 3
Laporte-Nathrop-Trump complex, severely eroded	81	. 2
Peat, muck, and alluvial land	249	. 7
Rock land	3, 708	9. 9
Rock outcrop	1, 352	3. 6
Stecum sandy loam, 8 to 40 percent slopes	356	1. 0
Stecum sandy loam, 0 to 8 percent slopes	79	. 2
Stecum sandy loam, 8 to 40 percent slopes, eroded	4, 513	12. 1
Stecum sandy loam, 0 to 8 percent slopes, eroded	716	1. 9
Stecum sandy loam, 8 to 40 percent slopes, severely eroded	6, 695	17. 9
Stony land, Buena Vista materials	192	. 5
Stony land, Chubbs materials	1, 236	3. 3
Trout Creek loam	879	2. 3
Trout Creek clay loam, eroded	278	. 7
Wellsville very fine sandy loam	232	. 6
Totals	37, 409	100. 0

are poorly drained, hydrophytic plants, including willows, sedges, rushes, and foxtail barley, predominate.

The surface soil is dark grayish brown or very dark grayish brown and ranges in depth from 4 to 12 inches. It may be calcareous or noncalcareous. The texture depends on the source of the parent material. Loam and silt loam predominate if the parent material was derived from limestone or shale; loam and gravelly sandy loam are dominant if some of the parent material was derived from granite, quartzite, or trachyte.

The underlying material covers almost the whole range of soil texture. It is calcareous in some places. The color varies widely but is predominantly dark grayish brown.

Alluvial land is well supplied with plant nutrients. It has a great capacity for storing water and releasing it slowly to maintain the flow of streams. The internal drainage is mainly good, but it varies from good to poor. The erosion hazard is slight. Little surface erosion takes place, but considerable damage has resulted from stream dissection, caving of streambanks, and, in places, deposition of raw soil materials.

Use and suitability.—All of this land type is vegetated, principally with grass. It presents few problems of management. It is highly productive. It is excellent for herbage and well suited to timber. Along the lower, more nearly level reaches of Trout Creek, where the streamflow is continuous, good picnic and camp sites are available.

Considerable care is required to prevent gullying and the consequent lowering of the water table. Where gullies develop, the productivity is materially reduced.

Management group 1.

Bassel sandy loam (Ba).—This is a deep, well-drained soil that has formed over old, gravelly and sandy, valley-filling sediments derived mostly from granite. In a few places the deposits appear to be remnants of old, high terraces. The relief is gently sloping to sloping. The gradient generally ranges from 3 to 8 percent, but the escarpments around the edges of the deposits have slopes of as much as 12 to 15 percent.

The vegetation consists mostly of ring muhly, blue grama, western wheatgrass, and scattered pinyon and juniper trees.

This is an inextensive soil. There are about a dozen tracts of it, and they are in four widely separated areas. The largest acreage is in the Stecum-Edloe soil management area.

Profile description:

Surface soil—
0 to 4 inches, brown to very dark grayish-brown sandy loam; moderate, fine, granular structure; very friable; noncalcareous.

Subsoil—
4 to 20 inches, light-brown to dark-brown sandy clay loam or gravelly sandy clay loam; moderate, medium, prismatic structure; crushes to fine, weak granules; friable; noncalcareous in upper part, calcareous in lower part.

Parent material—
20 inches +, pale-brown to brown gravelly sandy loam; massive or single grain; very friable; strongly calcareous.

The surface soil ranges from about 2 to 8 inches in thickness, and the subsoil, from about 12 to 20 inches. The texture of the parent material ranges from gravelly sand to gravelly sandy loam. A zone of calcium carbonate accumulation occurs in the upper part of the parent material and, in places, in the lower part of the subsoil.

This soil is moderately well supplied with plant nutrients. Water infiltrates rapidly, and the entire profile is permeable to roots, air, and water. The erosion hazard is moderate. The capacity to store water for slow release to streams is high. The capacity to supply moisture to plants is medium.

Use and suitability.—This soil has a cover of grass and a few scattered pinyon and juniper trees. It is well suited to herbage but only fairly well suited to timber. Very little is used for range. Because it occurs in small, widely separated areas, its use is largely determined by the uses of the associated soils; in most places these uses will be wildlife and recreation. Its capacity for sustained water yield is high.

Management group 2.

Bassel sandy loam, severely eroded (Bd).—This is a deep, well-drained soil that has formed from old, gravelly and sandy, valley-filling sediments derived mostly from granite. The slopes generally range from 3 to 8 percent, but some small areas have slopes of up to 12 or 15 percent.

This soil is like Bassel sandy loam except that it has lost through erosion most of its surface soil and, in places, part of its subsoil. In spots, part of the original surface layer remains, but its depth varies greatly within short distances. In some of the places where the subsoil is ex-

posed, the texture at the surface is gravelly sandy clay loam. The amount of gravel on the surface is generally greatest where erosion has been most severe, since gravel remains after the finer particles have been washed away. A few shallow to deep gullies have formed as a result of runoff.

This soil is droughty and lacking in fertility; consequently, the potential for the recovery of the vegetative cover is limited. The erosion hazard is severe because of heavy runoff. Although the underlying unconsolidated material has a great capacity for water storage, the rate of infiltration is much slower than in the uneroded phase; consequently, less water enters the soil. The total amount of water stored for slow release to streams is about medium.

Use and suitability.—Most of this soil is presently protected to aid the natural recovery of the vegetative cover. The vegetation is sparse, and there are many barren spots. Blue grama, western wheatgrass, foxtail barley, fringed sagebrush, pingue, and rabbitbrush are common. This soil is poorly suited to either herbage or timber. Most of it will be used in the same way as the associated Stecum soils. It is useful principally for sustained water yield, wildlife, and recreation.

Management group 3.

Buena Vista very stony sandy loam (Bs).—This is a well-drained soil of the uplands. It has formed mostly from material weathered in place from trachyte and tuff. In some places locally transported sediments were included in the parent material. The relief is undulating to strongly rolling, but small hilly areas that have gradients of 25 to 30 percent are included. The greater part of the acreage has a southerly exposure.

The vegetation is dominantly ring muhly, Arizona fescue, fringed sage, and pingue. There are a few patches of quaking aspen and ponderosa pine.

This is an inextensive soil. It occurs in medium-sized areas, principally in the Buena Vista-Rock land soil management area.

Profile description:

Surface soil—
0 to 10 inches, pale-brown to very dark grayish-brown stony sandy loam; weak to strong, very fine, granular structure; very friable; noncalcareous; approximately 40 percent stones; lower 4 to 7 inches is transitional to the subsoil, is about 65 percent stones, and has a subangular blocky structure.

Subsoil—
10 to 20 inches, pale-brown to dark grayish-brown stony sandy clay loam; moderate, fine, subangular blocky structure; friable; noncalcareous; approximately 70 percent stones; lower 2 to 5 inches is a strongly calcareous zone of calcium carbonate accumulation.

Parent material—
20 inches +, light-gray to grayish-brown stony sandy loam; friable; calcareous; 70 to 80 percent stones; weakly weathered trachyte bedrock at 36 to 48 inches.

The number of stones on the surface and in the soil varies widely. In places 70 to 90 percent of the surface is covered by stones. The upper part of the profile is generally 40 to 70 percent stones, by volume. The number of stones increases with depth, and the lower part of the profile is 50 to 95 percent stones (fig. 4).

The thickness of the surface soil varies from 3 to 10 inches. The texture ranges from stony sandy loam to very stony loam; in a few areas, it is gravelly fine sandy loam. The texture of the subsoil ranges from sandy loam or loam to clay loam. In places the surface soil, the subsoil, and the upper part of the parent material are noncalcareous, except for an accumulation of lime on the under sides of stones in the upper part of the parent material. There is considerable variation in the amount of stone in the profile, but generally the parent material and the lower part of the subsoil are more than 50 percent unweathered rock.

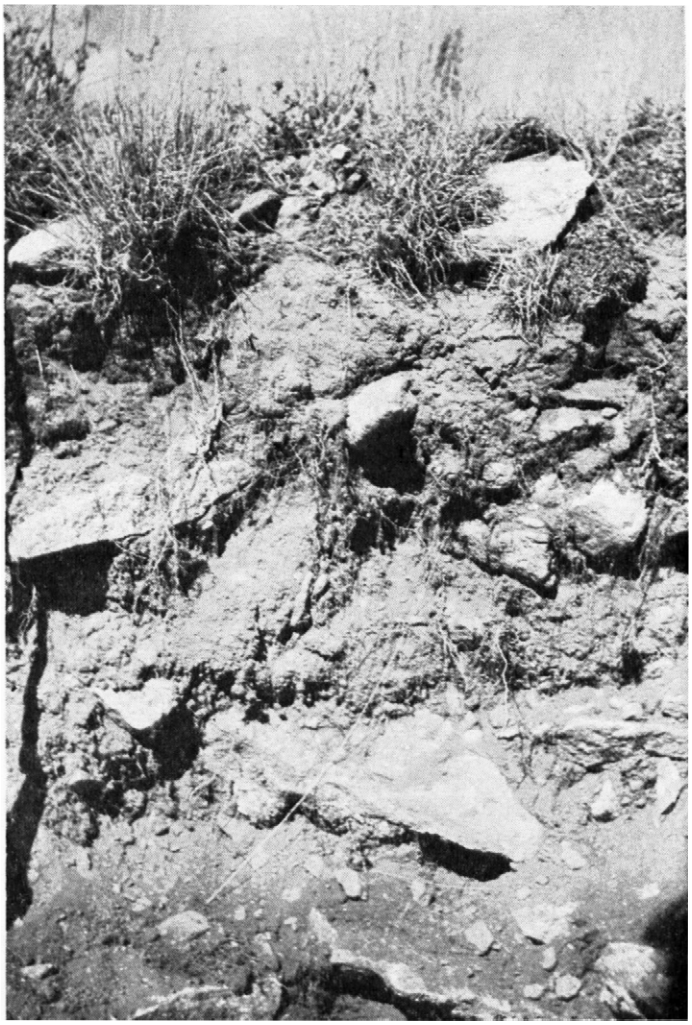

Figure 4.—**Very stony Buena Vista soils; highly fractured parent rock is pervious to water.**

Included in this mapping unit is an area of about 61 acres that has quartzitic rock on the surface and in the soil. The soil in this area has been influenced by trees, principally Douglas-fir, quaking aspen, oak brush, and some juniper. The parent material was derived chiefly from trachyte, but possibly some was derived from limestone. The uppermost 2 or 3 inches is very dark grayish-brown to black loam covered by about half an inch of forest litter. Below this, and extending to a depth of about 6 inches, is a layer of fine sandy loam that is light brownish gray to dark brown in color and has a weak, fine, granular structure. This is underlain by dark-brown, very plastic clay. The depth of the trachyte bed-

rock is about 11 inches. The entire profile is noncalcareous.

This soil is moderately fertile but somewhat droughty. Water infiltrates rapidly, but it also percolates rapidly through the soil, so that little of it is available to plants. But the capacity to store water and release it slowly to streams is high because the parent material and underlying rock are pervious. There is little runoff. The erosion hazard is slight to moderate.

Use and suitability.—Most of this soil is in grass, to which it is fairly well suited. It is poorly suited to timber, and only a minor acreage has a timber cover. It is useful principally for sustained yield of water.

Management group 2.

Buena Vista very stony sandy loam, eroded (Bv).—This is a porous, well-drained, sandy soil of the uplands. It has formed from the weathered products of trachyte and tuff. In places, some local colluvium and alluvium were included in the parent material. The exposure is southerly, and the relief is undulating to strongly rolling.

Because the profile and the underlying material are permeable, runoff is low and there are few gullies. As a result of differential erosion, the thickness of the remaining surface soil varies from 0 to 4 inches. The productivity is about medium but somewhat lower than that of the uneroded type. The capacity to supply water for plants is moderately low.

Practically all of this soil is in the Buena Vista-Rock land soil management area.

Use and suitability.—Most of this soil is in grass, but very little of it is being grazed. This soil is fair for herbage and poor for timber. Its capacity for sustained water yield is high. The lack of lakes and flowing streams limits its suitability for recreation.

Management group 2.

Buena Vista very stony sandy loam, severely eroded (By).—This soil has lost all, or nearly all, of its original surface layer and, in places, part of its subsoil. Locally, there are small areas where remnants of the original surface soil remain. The texture of the present surface layer varies within short distances from very stony sandy loam to sandy clay loam. The loss of the surface layer has increased runoff; as a consequence, rills and gullies are common. Areas where the subsoil is exposed dry out rapidly and become hard at the surface.

The fertility is low, and the capacity for supplying moisture to plants is low. Runoff is rapid, and the hazard of further erosion is severe. The loss of organic matter and plant nutrients, along with heavy runoff, slows natural revegetation. The capacity for water storage is medium.

This inextensive soil is in the Buena Vista-Rock land soil management area.

Use and suitability.—This soil is very poorly suited to herbage or timber. Erosion has impaired its productivity. It is useful principally for sustained yield of water.

Management group 3.

Chubbs clay loam (Ch).—This is a well-drained, moderately deep soil that occurs on north-facing slopes in the uplands. It has formed under forest from material weathered from Pennsylvanian limestone. Most of the parent material was weathered in place, but some was derived from outcrops of limestone and has been transported short distances. The relief is moderately sloping to steep; in general, the slope is less than 20 percent. The vegetation is mostly spruce, Douglas-fir, and quaking aspen trees. There is a sparse understory of shrubs and grasses, including Thurber's fescue, shrubby cinquefoil, mountain thermopsis, prostrate juniper, ferns, and strawberries.

Most of this soil is in the northern part of the watershed. Large areas of it are in the Chubbs-Nathrop-Trump soil management area, and a small acreage is in the Buena Vista-Rock land area.

Profile description:

½ to 0 inch, undecomposed and partly decomposed forest residues, mainly pine needles, bark, and woody branches.

Surface soil—
0 to 2 inches, dark-gray to very dark grayish-brown loam or gravelly loam; moderate, fine, platy structure; noncalcareous.

Subsoil—
2 to 12 inches, brown or dark-brown stony clay loam; moderate, medium and fine, subangular blocky structure; crushes to moderate, fine to medium granules; friable; hard when dry; noncalcareous; 20 to 30 percent or more limestone rocks.

Parent material—
12 to 20 inches, light-gray to dark grayish-brown stony or very stony loam; weak, very fine, granular structure; very friable; strongly calcareous; approximately 50 percent stones.

Bedrock—
20 inches +, partly weathered and fractured Pennsylvanian limestone.

The color of the surface layer varies from light gray to dark gray or from very dark brown to very dark grayish brown. The texture ranges from loam to silt loam. Limestone flags up to 12 inches in diameter occur on the surface in some areas. The surface soil may be 4 or 5 inches thick, or it may be lacking.

In some places there is a subsurface layer that is pink, light gray, or light brownish gray. This layer is weakly developed; it may be only half an inch thick or it may be not apparent upon casual observation. The texture of the subsoil ranges from light clay loam to heavy clay loam. The depth to unweathered limestone varies considerably and is difficult to determine because soil extends into fractures in the bedrock. The parent material is 50 percent or more rock.

This soil has a high fertility level. It is permeable to air and water and easily penetrated by roots. The rate of infiltration is variable but generally rapid; it depends on the amount of organic matter and forest litter. The erosion hazard is slight to moderate.

Because the profile is thin, the capacity to supply water to plants is only medium. The capacity to store water for slow release to springs and streams is medium.

As it is on north-facing slopes, this soil is somewhat colder than the associated Trump and Nathrop soils, which are on south-facing slopes. It is less droughty than south-facing soils that have equal water-holding capacity, because it warms up later in the growing season and loses less water through evaporation.

Use and suitability.—This soil has moderate capacity for sustained yield of water. It is well suited to herbage and fairly well suited to timber. Because of deep snow each winter and the lack of perennial streams, it is poorly

suited to big game. Inaccessibility and the scarcity of game limit its use for recreation.

The vegetative cover has been seriously depleted. The present stand of timber is not good. On the steeper slopes, more vegetation is needed to help control erosion and to maintain or increase the water yield.

Management group 4.

Edloe gravelly sandy loam (Ed).—This is a well-drained soil of the uplands. It has developed under forest vegetation on northerly exposures. The parent material weathered from granite that had inclusions of biotite schist. The relief is rolling to steep; most slopes have a gradient of about 45 percent. The soil pattern is complex, and there are numerous deep drainage channels.

Spruce and Douglas-fir trees dominate in the vegetative cover. The understory consists of brush and grass or, in places, a very sparse stand of timber oatgrass, muhly, and pingue. In places there are quaking aspen trees, mountain-maple trees, and snowberry bushes.

This soil occupies about 7 percent of the watershed. It occurs in both large and small areas and is closely associated with the Stecum soils. Practically all of it is in the Stecum-Edloe soil management area.

Profile description:

½ to 0 inch, decomposed and partly decomposed pine needles, bark, and woody plant remains.

Surface soil—
0 to 2 inches, gray to very dark grayish-brown gravelly sandy loam; moderate, fine, crumb structure; very friable; noncalcareous.

Subsurface layer—
2 to 8 inches, light-gray to pale-brown or grayish-brown gravelly loamy sand; weak, fine, platy structure; breaks to moderate, fine granules; very friable; noncalcareous.

Subsoil—
8 to 20 inches, pale-brown, brown, or dark yellowish-brown stony sandy clay loam; moderate, medium, subangular blocky structure; crushes to weak to moderate, fine granules; friable; hard when dry; noncalcareous; as much as 60 percent or more stones.

Parent material—
20 inches +, weathered rock, mostly granite but including some biotite schist; much of the rock is weathered to a stage where it can be crushed between the fingers; some fine-textured soil material extends into cracks in the rock.

The surface layer is generally 15 to 40 percent gravel. The subsurface layer may be only a faint suggestion of a gray layer, or it may be as much as 6 inches thick. Flakes of biotite mica are common; they occur throughout the profile and increase in number with depth. The depth to the weathered bedrock varies from 14 to 48 inches.

This soil is moderately low in fertility. It is permeable to air and water and is easily penetrated by roots. The rate of infiltration is rapid. The capacity to supply water to plants is moderately low. The surface layer, though thin, contains considerable organic matter.

The erosion hazard is severe, but the dense vegetation protects the soil from beating rains, and the organic litter on the surface absorbs water and retards runoff. Nevertheless, there is considerable runoff because the slopes are steep. If the protective cover of organic litter were to be destroyed, this soil would erode rapidly and thereafter would have little potential for recovery.

Use and suitability.—This soil is fairly well suited to herbage and timber but is better suited to wildlife and recreational uses. Its capacity for sustained water yield is only medium because the soil and the underlying unconsolidated material are rather shallow over bedrock.

Since this soil occupies northerly exposures, it is not good winter range for deer, but browse plants for summer grazing are more abundant than on the Stecum soils, which occupy southerly exposures. The rugged terrain and the timber cover provide excellent escape opportunities for deer. Big-game hunting is about the only recreational use at present. Most of the areas are not accessible from the principal roads, but some isolated areas are suitable for future development as picnic and camp grounds.

Most of this soil is now in timber or grass. The vegetation is needed to help control erosion.

Management group 4.

Garo clay loam (Ga).—This is a well-drained, moderately fine textured, shallow to moderately deep soil that has developed on southerly exposures in the uplands. The parent material was derived from calcareous, weakly metamorphosed Pennsylvanian shale and interbedded sandstone. Most of it weathered from shale, but there are fragments of sandstone in the soil in most areas. The relief is gently rolling to strongly sloping; the slope range is generally between 5 and 10 percent. Next to the drainageways, there are some steep slopes.

The vegetative cover is sparse. It consists mostly of ring muhly, blue grama, Arizona fescue, Thurber's fescue, and a little foxtail barley. Small amounts of pingue and fringed sage are included also, and in moist areas there is a little shrubby cinquefoil.

This inextensive soil occurs in a few fairly large, widely scattered tracts. Most of it is in the Garo-Heath-Trout Creek soil management area.

Profile description:

Surface soil—
0 to 3 inches, gray to very dark grayish-brown clay loam; moderate, fine, granular structure; friable; noncalcareous.

Subsoil—
3 to 9 inches, gray to very dark grayish-brown clay loam to silty clay loam; moderate, fine, subangular blocky structure; crushes to weak, fine granules; friable; noncalcareous.

Parent material—
9 to 13 inches, gray to very dark gray silty clay loam; moderate to strong, medium, platy structure; structure extremely variable; platiness largely inherited from the parent rock; friable; strongly calcareous (zone of calcium carbonate accumulation).

Bedrock—
13 inches +, olive-brown, dark-gray, or dark grayish-brown partly weathered platy shale.

The surface soil varies between loam and silty clay loam. The subsoil varies between sandy clay loam and silty clay loam and is 2 to 6 inches thick. The color of the subsoil and the parent material varies widely, and in places olive-brown colors predominate. The olive colors were inherited from the parent shale and sandstone, which also vary widely in color. There is a wide range in reaction; a few profiles are noncalcareous throughout, and others are calcareous to the surface. The depth to the partly weathered bedrock ranges from 8 to 24 inches. Locally, there are fragments of sandstone and shale on the surface and throughout the soil.

At the head of Mushroom Gulch there is an area in which the microrelief consists of a series of alternating

low ridges and flats. Very shallow soils underlain at about 8 inches by sandstone bedrock occupy the ridges; soils underlain at about 18 inches by shale and sandstone occupy the flats. Also in this area are small patches where there is quartzitic gravel on the surface. This gravel has weathered from minor inclusions of conglomerate.

This soil has a moderate rate of infiltration and percolation. It is about medium in fertility. Its capacity to supply water to plants ranges from low to medium, depending upon the depth to the bedrock. It has little capacity to store water for slow release to springs and streams. It is very unstable.

Use and suitability.—This soil is presently in grass. It is poorly suited to timber, wildlife, or recreation. It is only fairly well suited to herbage, but production of herbage is its best use. Careful management is necessary to protect the vegetation and to control erosion.

Management group 2.

Garo clay loam, severely eroded (Ge).—This soil has lost all, or nearly all, of its original surface layer. Small areas of exposed subsoil are common, and in places a part of the subsoil has been eroded away. There are numerous shallow to deep gullies. The depth to the partly weathered shale and sandstone is generally about 8 inches, but in some areas it is as much as 20 inches. Locally, there are numerous small outcrops of bedrock. It is common to find varying amounts of sandstone and shale fragments on the surface and throughout the profile. In a few areas, as much as 45 percent of the surface area is covered by flat fragments of sandstone that range from ¼ inch to 24 inches in diameter. The underlying shale may be black, gray, brown, or olive.

The vegetative cover is like that of the uneroded Garo clay loam but is even more sparse. Even where the subsoil is not exposed, vegetation rarely covers more than 30 percent of the surface. In areas where calcareous shale is exposed, wild roses are common, but they do not grow where the exposed shale is acid.

This soil is deficient in plant nutrients. It is very droughty and is highly susceptible to further erosion. The capacity for water storage is low because the profile is shallow and runoff is heavy.

Use and suitability.—This soil has little potential value for wildlife or recreation. It is poor to very poor for herbage, timber, and sustained water yield. Nevertheless, production of herbage and storage of water are its best uses. Its potential for recovery is low.

Management group 3.

Heath loam and clay loam (Hm).—These are well-drained, gently to strongly sloping, shallow to moderately deep soils that have developed in locally transported, valley-filling colluvium and alluvium. Pennsylvanian shale was the source of most of the parent material; sandstone, limestone, and other exposed rocks also contributed. The deposits are underlain at varying depths by shale.

All of the acreage is in Chubbs Gulch. It occurs on both sides of Trout Creek. The slopes are generally southeasterly and southwesterly, toward the creek. There are short, steep slopes toward minor tributaries of Trout Creek. The slope range, for the most part, is 4 to 8 percent.

Ring muhly, Arizona fescue, and western wheatgrass are dominant in the vegetative cover. Fringed sagebrush and pingue are very common.

Nearly all of this soil is in the Garo-Heath-Trout Creek soil management area.

Profile description:

Surface soil—
0 to 5 inches, grayish-brown to very dark grayish-brown loam or clay loam; moderate, very fine, granular structure; very friable; calcareous.

Subsoil—
5 to 18 inches, dark-gray to very dark grayish-brown clay loam; weak, medium, prismatic structure; breaks to subangular units that crush to fine granules; friable; calcareous; lower part is a zone of lime accumulation.

Parent material—
18 to 40 inches, light brownish-gray to dark grayish-brown gravelly loam or clay loam; weak, fine, subangular blocky structure that crushes to moderate, fine granules; friable; very strongly calcareous; this is a zone of calcium carbonate accumulation in which soft concretions, thin seams, and streaks of lime are visible.

Bedrock—
40 inches +, partly weathered shale.

The surface soil is 3 to 7 inches thick. Its texture ranges from loam to silty clay loam. In some areas there are fragments of sandstone on the surface and throughout the profile. The reaction varies widely; locally, the surface soil and, in some places, the subsoil are noncalcareous. The depth to the bedrock varies from 12 to 60 inches, and in places there are inclusions of sandstone.

These soils are low to medium in fertility and productivity. They are moderately permeable to water and air. The rate of infiltration is medium. The amount of water stored for plants is moderate. The capacity for storing water for slow release to springs and streams is low to medium. The inherent erosion hazard is severe.

Following heavy rains there are numerous small, seepy areas where the trails are almost impassible. The source of the seepage is the higher lying Trout Creek soils. The shale underlying the Trout Creek soils deflects water toward the surface, and the slowly pervious shale underlying the Heath soils causes temporary waterlogging.

Use and suitability.—These soils are presently in grass; a small part is grazed. They are well suited to herbage but only fairly well suited to timber. The scarcity of browse plants and of concealment limits suitability for wildlife. Recreational possibilities are few. Sustained yield of water and production of forage are the best uses. A dense cover of grass is necessary to control erosion.

Management group 2.

Heath clay loam, eroded (He).—This soil has lost part, and in places all, of its original surface layer. The present surface layer varies from clay loam to silty clay loam in texture. It is hard when dry. Erosion has reduced the rate of infiltration, impaired the water-storage capacity, and increased runoff.

This soil is droughty and very low in fertility. It is deficient in organic matter. The capacity for storing water for slow release to springs and streams is low to medium. The hazard of further erosion is high, and the potential for recovery is low.

This soil is in the Garo-Heath-Trout Creek soil management area.

Use and suitability.—This soil is in grass. It is useful principally for production of herbage and for sustained yield of water. Management requirements are more exacting than for Heath loam and clay loam.

Management group 2.

Laporte-Nathrop-Trump complex (Ln).—This complex consists of very shallow to moderately deep, well-drained soils that occur mainly on southerly exposures in the uplands. Weathered products of Pennsylvanian limestone, in many places mixed with local colluvium and alluvium, were the parent materials. The relief ranges from moderately sloping or gently rolling to steeply sloping. Most areas have slopes of 5 to 12 percent, but there is a minor acreage that has slopes of up to 30 percent.

Included are small areas that are excessively stony and rocky. Generally, 25 to 90 percent of the surface of these areas is barren rock. Between the stones and outcrops, there is dark-brown to very dark grayish-brown loam overlying brown or dark reddish-brown clay loam. The soil in these spots is 1 to 10 inches thick over bedrock.

The rocky areas have a sparse cover of ponderosa pine, spruce, and quaking aspen and an understory of prostrate juniper, peavine, timber oatgrass, and other grasses. Elsewhere, the cover is mainly grass. Different species dominate in different areas. Arizona fescue, Thurber's fescue, muhly, needle-and-thread, and blue grama are common grasses. Scattered through the grasses are fringed sage and pingue.

This is a fairly extensive mapping unit. It occupies about 5 percent of the watershed. It is associated mainly with Chubbs soils. Most of it is in the Chubbs-Nathrop-Trump soil management area.

Profile description of Laporte gravelly sandy loam:

Surface soil—
0 to 7 inches, gray to very dark gray (very dark grayish-brown when moist) gravelly sandy loam; moderate, fine, granular structure in upper part; weak, subangular blocky structure in lower part; violently calcareous; approximately 25 percent gravel.

Transitional layer—
7 to 12 inches, gray or light-gray (very dark grayish-brown when moist) gravelly sandy loam or light gravelly loam; weak, fine, subangular blocky structure breaking to moderate, fine crumbs; very friable; violently calcareous; a weak horizon of lime accumulation, with visible lime in the form of soft concretions; approximately 50 percent gravel.

Parent material—
12 to 21 inches, light-gray to dark grayish-brown or brown stony sandy loam; massive; soft when dry, very friable when moist; violently calcareous; a prominent horizon of lime accumulation, with visible lime in finely divided forms; approximately 50 percent stones.

Bedrock—
21 inches +, partly weathered and fractured Pennsylvanian limestone bedrock.

Varying numbers of limestone outcrops and limestone flags occur on the surface. The depth to the bedrock ranges from 6 to 24 inches.

The Laporte soils are moderately high in fertility. They are well drained, are permeable to air and water, and are easily penetrated by roots.

Profile description of Nathrop loam:

Surface soil—
0 to 4 inches, brown to dark-brown loam; weak, fine, subangular blocky structure crushing to moderate, fine granules; very friable; noncalcareous.

Subsoil—
4 to 13 inches, brown or reddish-brown to dark-brown or dark reddish-brown clay loam; weak, fine to medium, subangular blocky structure that crushes to moderate, fine granules; very friable; noncalcareous; lower part of horizon is a zone of lime accumulation.

Parent material—
13 to 19 inches, white to light brownish-gray or pale-brown gravelly loam; very friable; very strongly calcareous; a prominent zone of lime accumulation.

Bedrock—
19 inches +, partly weathered and fractured Pennsylvanian limestone.

The subsoil may be loam, silt loam, sandy clay loam, clay loam, or silty clay loam. The thickness of the soil over unweathered bedrock is difficult to determine, since the soil material extends into cracks in the rocks, but depths of 18 to 24 inches are common. The surface soil varies from brown to grayish brown when dry and from dark brown to dark grayish brown when moist. The subsoil is slightly hard when dry. In places the soil is calcareous at the surface.

This soil is moderately fertile. It is easily penetrated by roots and permeable to air and water. Infiltration is moderately rapid. The erosion hazard is moderate.

Profile description of Trump loam:

Surface soil—
0 to 4 inches, gray to very dark gray loam; moderate, fine, granular structure; very friable; noncalcareous.

Subsoil—
4 to 8 inches, brown to dark-brown loam; weak to moderate, fine, subangular blocky structure that breaks to moderate, fine, granular; very friable; noncalcareous; a color B horizon, with no increase in clay content over the surface soil.

Bedrock—
8 inches +, pale-brown to dark grayish-brown Pennsylvanian limestone; hard; partly weathered and fractured.

In places the surface layer is brown or dark brown. The subsoil ranges from light loam to clay loam but ordinarily it is no finer textured than the surface soil. The depth to the bedrock varies from 8 to 20 inches.

This soil is moderately well supplied with organic matter. It is moderately fertile. Its capacity for supplying water to plants is low. The erosion hazard is moderate.

The Laporte-Nathrop-Trump complex, as a whole, is moderately fertile. The shallow spots are droughty. The erosion hazard is moderate. The capacity for storing water for slow release to springs and streams is low to medium because the soils and unconsolidated underlying materials are thin. A relatively small proportion of the complex is moderately eroded. The potential for recovery is medium.

Use and suitability.—A minor part of this group of soils is used for range; most of the acreage is part of a rehabilitation area. The soils are moderately well suited to herbage and have moderate capacity for sustained water yield. They have little potential use for wildlife or recreation. They are useful principally for the storage of water and the production of timber. Because of droughtiness, revegetation of barren areas with either timber or grass would be difficult.

Management group 4.

Laporte-Nathrop-Trump complex, severely eroded (Lt).—The soils in this complex have lost all, or nearly all, of their original surface soil. They are low in fertility and very droughty. The thickness of the remaining surface soil varies greatly, and exposures of subsoil are common. Erosion has decreased the organic-matter content, reduced the rate of infiltration, and impaired the water-

holding capacity. The resulting increase in runoff causes further erosion and overburdens the drainageways.

All of this unit is in the Chubbs-Nathrop-Trump soil management area. The acreage is small.

Use and suitability.—These soils are poor for both herbage and timber. Their capacity for sustained water yield is low, mainly because of excessive runoff. If rehabilitated, they would be suited to storage of water and production of forage or timber. Rehabilitation would be slow, and establishing vegetation would be difficult because of droughtiness and low fertility. Any vegetation that can be established should be managed for protection against further erosion.

Management group 5.

Peat, muck, and alluvial land (Pm).—This mapping unit is on flood plains. Most of the areas have a high water table or impeded drainage. The vegetation consists of hydrophytic plants, mostly foxtail and sedges. In places there are a few willow trees.

Peat and muck consist mostly of plant remains. In peat, the plants are only partly decomposed and are still recognizable. In muck, they are decomposed beyond recognition. Muck contains more mineral matter than peat.

The peat deposits in this mapping unit (fig. 5) are brown and fibrous and generally noncalcareous. They are 2 to 12 inches deep and overlie thin layers of gray, strongly calcareous muck or mineral soil deposits.

The muck in this unit is black. It is 6 to 12 inches thick and overlies alluvium of varying texture. The alluvium is grayish in color, as a result of reduction of iron compounds.

The alluvial land is extremely variable in color, texture, depth, and drainage. It is like that described on p. 5.

Most of this mapping unit is in the Stecum-Edloe soil management area. The acreage is very small.

Use and suitability.—The better drained areas are well suited to herbage. The capacity for sustained water yield is high, except where it has been reduced by gullies. Where the water table is high, the surface is soft and is easily compacted by grazing animals. Willow and aspen grow well; they provide food and cover for beaver, deer, and other wildlife.

Management group 1.

Rock land (Rc).—Stones and rock outcrops cover 25 to 90 percent of the surface of this mapping unit. Depending upon the location, the rocks are granite, trachyte, tuff, sandstone, or, less commonly, limestone or conglomerate. The soils are thin and occur in patches or in pockets between rocks. The vegetation is sparse. The relief is predominantly very steep; it consists of mesa rims, steep talus areas below the rims, and a few narrow, mesalike ridges. The northerly exposures have more vegetation than the southerly exposures and, generally, more pockets of soil.

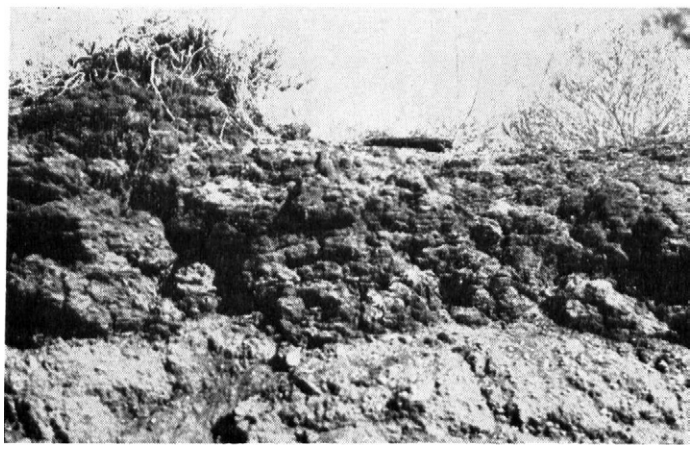

Figure 5.—Peat deposit overlying sandy alluvium.

Rock land occupies about 10 percent of the watershed. Most of it is in the Buena Vista-Rock land soil management area.

South of Trout Creek is an extensive area of Rock land consisting of rimrock and steep talus slopes of trachyte and tuff. The slopes in this area range from 30 percent to almost vertical. On the talus slopes, 50 percent or more of the surface is covered with stones ranging from 3 inches to more than 6 feet in diameter. Grass, mostly timber oatgrass and Arizona fescue, covers less than 10 percent of the surface. There are scattered pinyon and Douglas-fir trees and mountain-mahogany shrubs. On the rim of the mesa, a few pinyon, Douglas-fir, and ponderosa pine trees grow in cracks in the rock, but barren rock dominates. In pockets and crevices in the talus slopes there is some weakly developed soil that is moderately high in organic matter. Most of this soil is noncalcareous loamy sand that has a weak, very fine, granular structure. The loamy sand is up to 3 inches thick and is underlain by dark-brown, noncalcareous sandy loam. The depth to the bedrock is 6 to 10 inches in most places.

Other areas of Rock land consist of interbedded sandstone and shale bedrock and very small, scattered patches of undifferentiated soil. The profile described below is on a convex slope of 45 percent, in an area where more than 50 percent of the surface is sandstone bedrock.

Profile description:

0 to 1½ inches, brown to dark-brown very fine sandy loam; weak, fine, granular structure; very friable; noncalcareous.

1½ to 4 inches, grayish-brown or light brownish-gray to dark grayish-brown fine sandy loam; structureless (massive) to very weak, fine, subangular blocky structure; very friable; noncalcareous.

4 inches +, olive-gray to brown sandstone; partly weathered; moderately indurated; platy; weakly calcareous.

The vegetation in this area consists of pinyon, ponderosa pine, mountain-mahogany, and prostrate juniper. Unforested spots have about a 30 percent ground cover of Indian ricegrass, needle-and-thread, muhly, and pingue.

Rock land has little capacity for sustained water yield. Most of the storage capacity is in the talus material. Infiltration is rapid in the small patches of soil, but the capacity to store water for plants is low. Runoff is excessive.

Use and suitability.—Rock land will produce only enough herbage for light grazing. Vegetation is needed to help control runoff and erosion. Rock land provides concealment and escape for wildlife. It is useful principally for wildlife, recreation, and sustained yield of water.

Management group 5.

Rock outcrop (Ro).—Outcrops of bare rock dominate this mapping unit. Practically all of the rock is granite, but there are inclusions of biotite schist. Some areas contain scattered pockets of shallow soils, but all are 90 percent or more barren rock. Some of the outcrops stand high above the surrounding terrain. A few widely scat-

tered trees and very sparse patches of grass are the only vegetation. Runoff is rapid.

Rock outcrop occupies many widely scattered areas totalling about 1,300 acres. Much of it is in the Stecum-Edloe soil management area.

Use and suitability.—This land type is characterized by thin, patchy soils that are droughty and support very little vegetation. It adds somewhat to the scenic value of the area and provides concealment for big game. Wildlife and recreation are the best uses for it.

Management group 5.

Stecum sandy loam, 8 to 40 percent slopes (Sm).—This is a sandy, shallow, well drained to excessively drained soil that has developed on southerly exposures in the uplands. The parent material weathered from granite rocks having inclusions of biotite schist. Locally transported material derived from granite outcrops is included in the parent material in places, particularly on the lower foot slopes. For the most part, the relief is rolling to steep, but a minor acreage has slopes of up to 70 percent.

This soil is shallow, partly because the parent rock weathers slowly and partly because the slopes are so steep that geologic erosion removes the soil almost as fast as it forms. In most places the depth to the bedrock is 8 to 16 inches; on the lower foot slopes it is more.

Pinyon, juniper, mountain-mahogany, sagebrush, blue grama, spike muhly, ring muhly, and Arizona fescue dominate. In places there are some quaking aspen and ponderosa pine trees. Other common plants are kinnikinnick, pingue, yucca, and, in dry spots, pricklypear.

This soil occurs only in a few small areas near the boundaries of the watershed. It is in the Stecum-Edloe soil management area.

Profile description:

Surface soil—
0 to 4 inches, grayish-brown to very dark grayish-brown sandy loam or gravelly sandy loam; moderate, fine, granular structure; very friable; noncalcareous.

Parent material—
4 to 13 inches, yellowish-brown to brown gravelly loamy sand to sandy loam; structureless (single grain); friable; generally noncalcareous but locally calcareous.

Bedrock—
13 inches +, partly weathered granite bedrock that includes some biotite schist.

Outcrops of bedrock are common. Mica flakes occur throughout the profile in many places. Locally, the surface may be gravel free, but in most places the soil is 20 to 45 percent gravel by volume. In most places the depth to the bedrock is between 8 and 16 inches, but it varies from 3 to 24 inches or more. The areas north of Trout Creek and those on the lower foot slopes are calcareous. The texture of the parent material varies from gravelly sand to gravelly sandy loam. In a few areas a weak subsoil of gravelly sandy clay loam has developed.

This soil is moderately low in fertility. It is deficient in organic matter. It has a rapid rate of infiltration and is permeable to air and water. Runoff is rapid, and drainage is good to excessive.

The capacity to store water for plants is low. Because of this and because it occurs on warm, south-facing slopes, this soil is somewhat droughty. Its capacity for sustained water yield is low because the unconsolidated material over the bedrock is shallow and pervious (fig. 6). The erosion hazard is high.

Use and suitability.—Although the potential sustained water yield is low, water storage is the best use for this soil. It is poor for either herbage or timber. It is well suited to wildlife, particularly deer and elk. Rocky areas and rugged terrain provide concealment and escape opportunities, and the warm, south-facing slopes make good winter range. There are no perennial streams, consequently, no fish. Big-game hunting is about the only recreational use at present.

Management group 5.

Stecum sandy loam, 0 to 8 percent slopes (Sc).—This soil has a somewhat thicker profile than Stecum sandy loam, 8 to 40 percent slopes. It has a somewhat thicker and darker colored surface soil and fewer and less extensive outcrops. The relief ranges from gently sloping or undulating to sloping. The dominant slope gradient is about 5 percent.

This is a very inextensive soil. The few small areas, totaling about 80 acres, are in the Stecum-Edloe soil management area.

Use and suitability.—Practically all of this soil is idle and is protected as part of a rehabilitation program. The potential sustained water yield is higher than that of Stecum sandy loam, 8 to 40 percent slopes, because the layer of unconsolidated parent material is slightly thicker. Water storage, wildlife, and recreation are the best uses.

Management group 5.

Stecum sandy loam, 8 to 40 percent slopes, eroded (Sn).—This soil is moderately eroded. There are small areas where the underlying material is exposed. Varying amounts of gravel have accumulated on the surface, as a

Figure 6.—Stecum soil; bedrock is near surface, and capacity for sustained water yield is low.

result of differential erosion. The depth to bedrock varies widely; in places, it is about 14 inches, but a depth of between 6 and 10 inches is more common.

This soil has little potential for recovery. Owing to the loss of surface soil and its incorporated organic matter and to the resulting increased runoff, this soil is more droughty than the uneroded Stecum sandy loam, 8 to 40 percent slopes. It has a low capacity for storing water for plants and for sustained yield of water. It is deficient in plant nutrients.

This is an extensive soil. It occupies about 12 percent of the watershed. It is in the Stecum-Edloe soil management area.

Use and suitability.—Water storage, wildlife, and recreation are the best uses for this soil. Its capacity for sustained water yield is low, and its suitability for timber or herbage is very low because of droughtiness and low fertility. Recreation is largely limited to big-game hunting. Perennial streams are lacking.

Management group 5.

Stecum sandy loam, 0 to 8 percent slopes, eroded (Se).—This soil is moderately eroded. The relief ranges from gently sloping or undulating to sloping. The depth of the remaining surface soil varies widely within short distances, and there are small areas where the underlying material is exposed. A few rills and gullies have formed. As a result of differential erosion, considerable gravel has accumulated on the surface in places.

A considerable part of this soil is on low foot slopes where some colluvium and alluvium have accumulated. In these places, the depth to the bedrock is slightly greater than on the steeper slopes and the potential water yield is correspondingly higher.

This soil is droughty, though less so than Stecum sandy loam, 0 to 8 percent slopes. It is lacking in fertility and is highly erodible.

This soil occupies about 2 percent of the watershed. Most of it is in the Stecum-Edloe soil management area.

Use and suitability.—This soil is poor for herbage and very poor for timber. Its capacity for sustained water yield is low. It is useful principally for water storage, wildlife, and recreation.

Management group 5.

Stecum sandy loam, 8 to 40 percent slopes, severely eroded (Ss).—This soil has lost all, or nearly all, of its original surface layer. It is unevenly eroded; extensive areas of exposed parent material adjoin small patches that still have several inches of the original surface soil. Numerous rills and gullies have formed. There is considerable gravel on the surface; it was left when the finer particles were washed away.

This soil has very little potential for recovery. It is deficient in plant nutrients and organic matter. Its capacity for storing water, either for plants or for sustained yield, is low. Because of the southerly exposure, the soil dries out rapidly and may become hard at the surface.

This soil occupies about 18 percent of the watershed. Most of it occurs in large areas in the Stecum-Edloe soil management area.

Use and suitability.—This soil is useful principally for sustained water yield, wildlife, and recreation. Because of steep slopes, shallowness, and droughtiness, it is not well suited to herbage or timber. Plantings of grass and trees are likely to fail. The rugged, rocky terrain provides interesting scenery. Areas suitable for campgrounds and picnic areas are scarce because the slopes are generally too steep. Hunting is the principal recreational use. Browse plants are not plentiful, but otherwise the areas are suitable for big game. Trout fishing is limited to Trout Creek and is not of much importance at present.

Management group 5.

Stony land, Buena Vista materials (St).—This land type is like Buena Vista very stony sandy loam except that it has more stones on the surface and in the soil and is somewhat more droughty. Gravel, cobblestones, and stones up to about 24 inches in diameter cover 70 to 90 percent of the surface. About 90 to 95 percent of the underlying material consists of stones. The areas of soil available for growing plants are limited.

This is an inextensive soil. It is in the Buena Vista-Rock land soil management area.

Use and suitability.—This soil is poor for herbage or timber. It has a medium capacity for sustained water yield. It supplies somewhat less herbage than Buena Vista very stony sandy loam because such a large proportion of its surface consists of bare stones. The stones are of such a size and number as to interfere materially with any kind of revegetation.

Management group 5.

Stony land, Chubbs materials (Sy).—This land type differs from Chubbs clay loam mainly in being excessively stony. A very large proportion of the surface is covered by limestone flags, boulders, and bedrock outcrops. The color, texture, and thickness of the soil layers are more variable than in Chubbs clay loam. The depth to bedrock ranges from a few inches to 18 inches. The water-supplying capacity is less than that of Chubbs clay loam, and runoff is more rapid.

This land type occupies more than 3 percent of the watershed. Almost all of it is in the Chubbs-Nathrop-Trump soil management area.

Use and suitability.—This land is only fair for herbage or timber. Its capacity for sustained water yield is moderate. At present, there is no grazing or timber cutting. The stones and rocks would interfere with planting or reseeding.

Management group 4.

Trout Creek loam (Tr).—This is a well-drained, shallow to moderately deep soil that occupies north-facing slopes in the uplands. It has developed in calcareous material weathered from interbedded, weakly metamorphosed Pennsylvanian shale, sandstone, and limestone. Most of the parent material was derived from shale, but enough of it was derived from sandstone, limestone, and locally transported material to give the soil a variegated color pattern. The relief is undulating to rolling; slopes of 5 to 10 percent predominate.

The vegetation varies. Generally it includes spruce and a little ponderosa pine. Arizona fescue, muhly, junegrass, western wheatgrass, fringed sagebrush, and pingue are common.

This soil occupies only 2 percent of the watershed. Most of it is in one large tract in the Garo-Heath-Trout Creek soil management area. The Chubbs, Heath, and Garo are associated soils.

Profile description:

Surface soil—
0 to 5 inches, brown or dark-brown to very dark gray loam; moderate, fine, granular structure; very friable; noncalcareous.

Subsoil—
5 to 16 inches, brown to dark-brown clay or clay loam; strong, very fine, subangular blocky structure; crushes to moderate, fine granules; very friable; noncalcareous in upper part, calcareous in lower 4 to 6 inches.
Parent material—
16 to 22 inches, light-gray to grayish-brown or dark grayish-brown clay loam; moderate, fine, subangular blocky structure; crushes to weak, fine granules; friable; calcareous; a zone of calcium carbonate accumulation.
Bedrock—
22 inches +, light yellowish-brown, olive-brown, or dark-gray to very dark gray interbedded shale and sandstone; partly weathered; strongly calcareous.

The colors are extremely variable; they depend upon the amount of sandstone and limestone products in the parent material. The surface soil may be brown, dark brown, grayish brown, very dark gray, or very dark grayish brown. The subsoil may be yellowish brown, brown, dark brown, grayish brown, or reddish brown but is usually variegated. Included are some areas that have a clay loam surface soil. The texture of the subsoil and parent material varies from clay loam to silty clay loam or clay. The depth to the bedrock ranges from 6 to 30 inches. In some places the zone of lime accumulation in the lower subsoil is lacking, and in a few others the soil is calcareous throughout.

This is a moderately fertile soil. The rate of infiltration and percolation is moderately rapid, but the water storage capacity is limited because the total thickness of the soil and the parent material over bedrock is generally no more than 2 to 2½ feet. The underlying shale deflects water so that it does not penetrate to any great depth but seeps out on the lower slopes. The inherent erosion hazard is severe.

Use and suitability.—The vegetative cover is depleted, but if well managed this soil is well suited to herbage. Because of the erosion hazard, extremely careful management is needed. This soil is only fairly well suited to timber, and it has little potential use for recreation or wildlife. It is useful principally for sustained water yield, even though the storage capacity is medium to low.

Management group 2.

Trout Creek clay loam, eroded (Tc).—This soil has lost part, and in places all, of its original surface soil. It is more droughty and more erodible than Trout Creek loam, and it loses more water through runoff. It is deficient in organic matter and plant nutrients. When dry, the surface layer is hard; when wet, the clay swells and becomes less permeable. Gravel fragments of sandstone, limestone, and shale are common on the surface; these have accumulated as a result of erosion. There are many rills and a few gullies.

This soil is in the Garo-Heath-Trout Creek soil management area and is closely associated with Trout Creek loam. There are three small, widely separated areas, which total less than 1 percent of the acreage of the watershed.

Use and suitability.—This soil has a fair potential for vegetative recovery. The erosion is largely a result of past use. Increasing the density of the grasses is difficult because of low fertility and droughtiness. The capacity for sustained yield of water is low to medium. Nevertheless, storage of water and production of forage are the best uses for this soil. It is poor for timber.

Management group 2.

Wellsville very fine sandy loam (We).—This is a deep, well-drained soil. It has formed in deep colluvial-alluvial deposits underlain by shale. Most of the colluvium and alluvium was weathered from granitic rocks and limestone; some was derived from trachyte and tuff. The underlying shale, which crops out in places on the lower part of the slopes, has also contributed parent material. The relief is gently to strongly sloping; the slopes range from 4 to 10 percent.

Arizona fescue, muhly, western wheatgrass, and fringed sagebrush are the most common native plants. There are scattered pinyon and juniper trees.

All of this soil is in the Garo-Heath-Trout Creek soil management area, in association with Garo and Heath soils. There are 13 small areas, and the total acreage is only about half of 1 percent of the acreage of the watershed.

Profile description:

Surface soil—
0 to 6 inches, grayish-brown to very dark grayish-brown very fine sandy loam; moderate, fine, granular structure; very friable; noncalcareous.
Subsoil—
6 to 18 inches, brown to dark-brown clay loam; weak to moderate, medium, prismatic structure; breaks to weak to moderate, medium, subangular blocks that crush to medium, fine granules; friable when moist, hard when dry; noncalcareous in upper part; strongly calcareous (zone of lime accumulation) in lower part.
Parent material—
18 to 60 inches +, light-gray to grayish-brown clay loam; channery; structureless (massive) to weak, very fine, granular structure; friable; violently calcareous (zone of lime accumulation); about 25 percent of material is fragments of limestone and shale.

The depth to the bedrock generally exceeds 26 inches; near the base of the colluvial-alluvial slopes, the depth is less and there are a few outcrops of bedrock. A small acreage is moderately eroded and has a few gullies. In these eroded areas the surface soil is clay loam and there is a considerable amount of gravel and of limestone and shale fragments on the surface. In some areas the parent material may be as much as 75 percent limestone and shale fragments up to 6 inches in diameter, and it may include some pebbles of trachyte or tuff.

This is a fertile soil. It is permeable to air and water and easily penetrated by plant roots. Infiltration is moderately rapid. The capacity for supplying water to plants is high, as is also the capacity for storing water for slow release to springs and streams. The erosion hazard is moderate.

Use and suitability.—This soil has been used for grazing. It is well suited to herbage but only fairly well suited to timber. It is useful principally for sustained yield of water and production of herbage. Recreation and wildlife are not important uses. Eroded areas and areas depleted of vegetation have a high potential for recovery.

Management group 2.

Summary of Soil Characteristics

The major characteristics of the soils of Trout Creek Watershed are summarized in table 4. The information in this table is given by soil series; consequently, it is somewhat generalized. For specific information about each mapping unit, refer to the descriptions just preceding.

TABLE 4.—*Major characteristics of*

Series or land type	Parent material	Position	Dominant relief	Surface soil			
				Color	Consistence and texture	Thickness	pH
						Inches	
Alluvial land [1]	Recent mixed alluvium.	Bottom lands	Nearly level to gently sloping.	Dark grayish brown to very dark grayish brown.	Very friable gravelly loam to silt loam.	4 to 12	8.0
Bassel	Valley-filling sediments, dominantly granitic.	Valley fill	Gently sloping to sloping.	Brown to very dark grayish brown.	Very friable gravelly sandy loam to loam; sandy clay loam where severely eroded.	0 to 8	6.8
Buena Vista	Material weathered in place from tuff and trachyte.	Uplands; southerly exposures.	Undulating to strongly rolling.	Pale brown to very dark grayish brown.	Very friable stony sandy loam, stony loam, or very stony sandy loam; very stony sandy clay loam in places.	0 to 10	6.5
Chubbs	Partly material weathered in place from limestone, and partly transported material weathered from limestone.	Uplands; northerly exposures.	Moderately sloping to steep.	Dark gray to very dark grayish brown.	Very friable loam or very stony loam; clay loam or very stony clay loam in places.	0 to 5	6.5
Edloe	Material weathered in place from granite, with inclusions of biotite schist.	Uplands; northerly exposures.	Rolling to steep.	Gray to very dark grayish brown.	Very friable gravelly sandy loam to gravelly fine sandy loam.	2 to 9	7.0
Garo	Material weathered in place from sandstone and shale; some locally transported material; minor inclusions of conglomerate.	Uplands; southerly exposures.	Gently rolling to strongly sloping.	Gray to very dark grayish brown.	Friable clay loam to silty clay loam.	0 to 4	6.8
Heath	Local alluvium and colluvium from uplands underlain chiefly by shale.	Valley fill	Gently sloping to strongly sloping.	Grayish brown to very dark grayish brown.	Very friable loam or clay loam.	0 to 6	8.0
Laporte [2]	Material weathered in place from limestone.	Uplands; southerly exposures.	Gently rolling to steeply sloping.	Gray to very dark grayish brown.	Very friable gravelly sandy loam.	5 to 10	8.0
Nathrop [2]	Material weathered in place from limestone; admixture of locally transported material.	Uplands; southerly exposures.	Gently rolling to steeply sloping.	Brown to dark brown.	Very friable loam	0 to 5	7.0
Peat, muck, and alluvial land. [1]	A land type consisting of moist areas where accumulated organic matter is closely associated with unconsolidated						
Rock land [1]	A land type consisting mostly of rock outcrops and very shallow soils; includes mesa rims and steep areas that are						
Rock outcrop [1]	A land type in which bare rock outcrops predominate; includes areas of rimrock and areas that are more than 90						
Stecum	Material weathered in place from granite with inclusions of biotite schist.	Uplands; southerly exposures.	Rolling to steep.	Grayish brown to very dark grayish brown.	Very friable sandy loam or gravelly sandy loam.	0 to 7	6.8
Trout Creek	Material weathered in place from shale, sandstone, and limestone; some locally transported.	Uplands; northerly exposures.	Undulating to rolling.	Brown to very dark gray.	Very friable loam	1 to 6	7.5
Trump [2]	Material weathered in place from limestone; some locally transported material.	Uplands; southerly exposures.	Moderately to steeply sloping.	Gray to very dark gray.	Very friable loam	1 to 4	7.0
Wellsville	Old alluvium and colluvium derived from granite, limestone, and shale.	Valley fill	Gently to strongly sloping.	Grayish brown to very dark grayish brown.	Very friable very fine sandy loam.	2 to 6	6.8

[1] Miscellaneous land type (see Glossary).

[2] The Laporte, Nathrop, and Trump soils are not mapped separately but are mapped in the Laporte-Nathrop-Trump complex.

[3] This is the upper part of the C horizon (parent material); the

the soil series and land types

Subsoil				Substratum		Depth to bedrock
Color	Consistence and texture	Thickness	pH	Color	Consistence, texture, and other charactersitics	
		Inches				*Inches*
None	Variable			Dark grayish brown	Friable gravelly loamy sand to light silty clay loam; noncalcareous to strongly calcareous.	36+
Light brown to dark brown.	Friable sandy clay loam	12 to 20	6. 8	Pale brown to brown	Very friable gravelly sand to gravelly sandy loam; strongly calcareous.	60+
Pale brown to dark grayish brown.	Friable stony sandy clay loam.	5 to 20	6. 8	Light gray to grayish brown.	Friable, calcareous stony sandy loam.	7 to 36
Brown or dark brown	Friable stony clay loam	7 to 13	6. 5	Light gray to dark grayish brown.	Very friable, strongly calcareous stony or very stony loam.	8 to 20
Pale brown to dark yellowish brown.	Friable stony sandy clay loam.	10 to 25	6. 8	Pale brown to dark yellowish brown.	Noncalcareous mixture of soil and weathered granite.	14 to 33
Gray to very dark grayish brown.	Friable heavy clay loam or silty clay loam.	3 to 10	7. 0	Gray to very dark gray.	Friable, strongly calcareous silty clay loam.	8 to 24
Dark gray to very dark grayish brown.	Friable clay loam	10 to 24	8. 0	Light brownish gray to dark gray or dark grayish brown.	Friable, calcareous gravelly loam or clay loam.	20 to 60
(No subsoil)				Light gray to brown	Very friable stony sandy loam.	14 to 21
Brown to dark reddish brown.	Very friable clay loam	5 to 10	7. 0	White to pale brown	Very friable, calcareous gravelly loam.	18 to 24
alluvium; little or no profile development						36+
excessively stony or have numerous outcrops of sandstone, trachyte, conglomerate, limestone, and granite						
percent bare rock						
Pale brown, brown, or dark yellowish brown.[3]	Friable gravelly loamy sand or gravelly sandy loam.[3]	5 to 11	6. 8	Yellowish brown to brown.	Friable gravelly loamy sand to gravelly sandy loam; locally calcareous.	4 to 18
Brown to dark brown, variegated reddish brown.	Very friable clay or clay loam.	10 to 14	7. 5	Light gray to dark grayish brown.	Friable, calcareous clay loam.	6 to 30
Brown to dark brown	Very friable loam[4]	1 to 5	7. 0	Pale brown to dark grayish brown.	Partly weathered and fractured limestone.	6 to 18
Brown to dark brown	Friable clay loam	8 to 12	6. 8	Light gray to grayish brown.	Friable, calcareous clay loam; many limestone and shale fragments.	26+

Stecum soils do not normally have a B horizon (subsoil).

[4] The Trump soils have a color B horizon but not a textural B horizon—that is, there is no noticeable increase in clay, as compared with the A horizon.

Formation of Soils

Parent material, climate, living organisms, relief, and time are the principal factors in soil formation. The kind of soil that develops in any given place depends on the interaction of the five principal factors (*11*).

Climate and living organisms are the active factors. The degree to which these influence soil characteristics depends on the kind of parent material, the local relief, and the length of time the parent material has been in place. The character of the vegetation is determined in part by the climate. The effect of climate is modified by relief, which influences drainage and runoff and, consequently, the amount of water that percolates through the soil. Drainage and runoff are further modified by the parent material and the underlying bedrock. The nature of the parent material modifies the effects of climate and vegetation. Differences in resistance to weathering account, to a considerable degree, for differences in the rate of soil development. Time affects the depth to which the soil has developed and the number, kind, and character of the horizons. Its effect is modified by relief and by the nature of the parent material. On steep slopes, geologic erosion may practically keep pace with soil development, and the soil may remain immature because of the removal of the weathered surface materials and the deposition of relatively unweathered parent materials.

Significant variations in any one of the major soil-forming factors can account for differences in the kind of soil that develops. In mountainous areas, of which the Trout Creek Watershed is an example, it is common to find variations in one or more of the soil-forming factors within short distances.

Parent material

Igneous rocks, metamorphic rocks, sedimentary rocks, and unconsolidated deposits have all contributed parent material for the soils in the Trout Creek Watershed. Exposed bedrock from which soil material has weathered includes Pennsylvanian shale, Pennsylvanian sandstone, Pennsylvanian limestone, granite, gneiss, biotite schist, trachyte, tuff, quartzite, and conglomerate. The gneiss and biotite schist occur as inclusions in the granite, and the tuff as inclusions in the trachyte. Quartzite, sandstone, and conglomerate are not important as sources of parent material.

In the uplands the soil material is residuum weathered from these rocks. In the valleys it is unconsolidated recent alluvium and colluvium derived from rocks and soils of the uplands, and it may or may not resemble the underlying rock.

Granite of Precambrian age is extensive in the survey area; it covers roughly two-thirds of the southern half. This granite is coarse grained and has many inclusions of biotite schist. To a considerable depth, it is sufficiently weathered to be easily crushed between the fingers. It is composed chiefly of quartz and feldspar; in most places, mica flakes derived from the biotite schist inclusions are common.

The soils that developed from the weathered products of granite are sandy and pervious. As a result of differential weathering and differential erosion, these soils commonly contain considerable gravel and numerous rock fragments. In many places they contain mica flakes inherited from the biotite schist inclusions. Physical disintegration and erosion of the clay-forming feldspar proceed more rapidly than chemical weathering; consequently, the soils derived from granite are low in clay and are highly erosive because they lack a binder to stabilize the aggregates. The soils on steep south-facing and west-facing slopes, where geologic erosion is rapid, are Regosols and Lithosols, and their characteristics are largely inherited from the parent material.

The soils derived from granite are not well supplied with plant nutrients and are, therefore, not very productive. For the most part they are noncalcareous, but locally there are areas where the soils are calcareous. In most places the reaction is slightly acid or neutral.

Trachyte is a fine-textured rock. The trachyte in this area consists of intrusions of Tertiary age. It is composed chiefly of feldspar but contains minor amounts of dark-colored minerals, including biotite, hornblende, augite, and magnetite. It covers about one-third of the southern half of the watershed.

The soils derived from trachyte are stony, sandy, and pervious. They are fairly stable, owing to rapid infiltration and a pervious subsoil and substratum. Sandy loam textures predominate, except in the thin B horizon. The underlying bedrock is highly fractured and pervious to water.

The soils derived from trachyte vary widely in reaction. In most places they are noncalcareous except in the lower part of the subsoil and parent material. In other places they are noncalcareous throughout, except on the undersides of rocks. The surface soil is generally slightly acid (pH about 6.4 to 6.8).

For the most part, soils developed from the weathered products of this rock are low to medium in fertility.

Pennsylvanian limestone, which includes some dolomite, dates from the Paleozoic era. This formation is somewhat resistant to weathering and forms long, steeply sloping ridges. It is composed chiefly of calcium and magnesium carbonates, and its principal impurity is clay. It occupies roughly one-half of the northern portion of the watershed.

The soils derived from limestone and dolomite are high in silt and clay and contain many fragments of the parent rock. These soils are fairly stable; the erosion hazard is slight to moderate. The soils are generally pervious to air, roots, and water. Fine textures predominate; the texture of the surface soil ranges from loam to clay loam.

Some of the soils derived from limestone are noncalcareous at the surface, while others are calcareous throughout. The reaction of the surface soil is slightly acid or neutral. The fertility is moderate to high.

Only a very small area is occupied by soils derived entirely from sandstone. This area is on the eastern edge of the northern half of the watershed. The soils are Lithosols, but they occupy such a small acreage that they have been included with Rock land and Rock outcrop.

Pennsylvanian shale or interbedded sandstone and shale unconformably overlie the Precambrian schist, gneiss, and granite. Generally the strata are horizontal, but in places they are tilted and may be nearly vertical so that exposures of shale alternate with interbedded sandstone. The shale is a soft, unstable rock that weathers readily. Both the sandstone and shale are calcareous in places and

noncalcareous in other places. The shale is predominantly gray, but locally it is black. The greater resistance of the sandstone has resulted in low, more or less parallel ridges.

Roughly one-third to one-half of the northern half of the watershed is occupied by soils derived from the weathered products of these rocks. These soils are silty and clayey and unstable. Because they are unstable they are generally shallow, even though the underlying rocks weather readily. The olive color in the lower part of the subsoil in many places is inherited from the parent material. Shallow, sandy soils that contain many sandstone fragments occupy the low ridges formed by the more resistant sandstones.

The reaction varies widely from place to place. The surface soils are noncalcareous and slightly acid (pH 6.5 to 6.8). In many places the soils are calcareous throughout, and the surface soil has a pH of 7.0 to 8.0. The fertility is low to medium. Severely eroded areas are very deficient in plant nutrients. Water is deflected toward the surface by the underlying shale, so there are many seep spots after rains.

The unconsolidated deposits include old valley-filling sediments, remnants of old high terraces, and more recent colluvium and alluvium. These parent materials vary widely in texture, depending upon the nature of the rocks from which they were derived. Sediments derived from granite, trachyte, and sandstone are sandy and gravelly; those derived from limestone and shale are fine textured. Alluvial land along the narrow stream bottoms differs widely in texture within very short distances. Colluvial or colluvial-alluvial deposits at the base of steep mountain slopes have textures similar to those of the rocks from which they have been washed or moved.

The physical characteristics of the soils that developed in these unconsolidated deposits are closely related to the characteristics of their parent materials. Sandy, gravelly deposits derived from granite, trachyte, or sandstone have given rise to pervious, sandy, gravelly soils. Deposits that were derived from or have been strongly influenced by limestone or shale have developed into moderately pervious, fine-textured soils. Sediments derived from shale have given rise to unstable soils. Soils that developed in sediments derived from granite and trachyte or from sediments influenced by sandstone are considerably more stable. Sediments with a strong limestone influence have resulted in the most stable soils, since the clays weathered from these materials result in comparatively stable soil aggregates.

Few soils in this area have developed in sediments derived entirely from one kind of rock, but in any given place the influence of one or more kinds predominates. On the broader stream bottoms the sediments are a mixture of materials from all of the rocks but are influenced by the rocks of the adjacent uplands. A minor part of the bottom lands has impeded drainage, and small areas of peat and muck are common in such places.

Soils that developed on well-drained valley-filling sediments are generally noncalcareous (pH 6.0 to 7.5). Locally, in severely eroded areas, the soils are calcareous at or near the surface. Distinct zones of calcium carbonate accumulation are common in the B or C horizons. Alluvial land differs widely in reaction; in some areas it is noncalcareous and in others it is calcareous throughout. Soils that have buried A horizons are common in these alluvial sediments along the streams.

Except where severely eroded, soils derived from unconsolidated alluvial and colluvial deposits are moderately productive. Severely eroded areas are low in fertility, but elsewhere the soils are moderately well supplied with plant nutrients. Peat is deficient in some of the plant nutrients, especially phosphorus and potassium, and consequently is low in productivity.

Relief

Relief influences soil formation through its effect on the other soil forming factors. Differences in elevation and aspect are associated with differences in climate and vegetation. In Trout Creek Watershed, shallow soils that have little or no horizonation are common on south-facing and west-facing slopes, and soils that have relatively strong horizonation are common on east-facing and north-facing slopes. The differences result partly from the greater density of vegetation on the east-facing and north-facing slopes and partly from more severe erosion on the west-facing and south-facing slopes, which are more affected by alternate freezing and thawing.

Slope gradient affects runoff and erosion. On steep, south-facing slopes in the uplands in Trout Creek Watershed, the effect of erosion on soil development is very conspicuous. Most of the soils in such locations are Regosols or Lithosols.

The influence of aspect on soil formation is most significant at the highest elevations and where the relief is most pronounced. On steep mountainsides in the survey area, Regosols have developed on southerly exposures and Gray Wooded soils on northerly exposures, even though the slope may be the same. At lower elevations and on more gentle relief, differences in aspect have much less effect.

The significance of aspect is closely tied to its influence on climate and vegetation, as discussed in the following sections.

Slope configuration as well as gradient influences soil characteristics. Soils in concave areas, where sediments and moisture accumulate, have thicker profiles than soils on convex slopes, where erosion is active. In Trout Creek Watershed, the soils in colluvial-alluvial positions have thicker profiles than any of the soils in the uplands, and they have stronger horizon differentiation than any of the soils except those on north-facing slopes, where the effects of climate and vegetation are most pronounced. Several factors contribute to this. The slopes are gentle, consequently there is less erosion and the soil-forming processes are not interrupted. The unconsolidated material weathers more readily than the parent material in other locations. Additional moisture received as runoff from the uplands results in deeper leaching and in greater density of vegetation.

Only a small acreage in the watershed is affected by impeded drainage caused by relief.

Vegetation

The soil characteristics most affected by vegetation are the thickness, structure, and organic-matter content of the A_1 horizon. Three principal types of vegetative cover occur in Trout Creek Watershed: pinyon-juniper and mountain bunchgrass, which occur at the lower elevations,

and coniferous forest, which occurs at the highest elevations and extends to somewhat lower elevations on north-facing slopes.

The soils that developed under mountain bunchgrass have an A_1 horizon that is 3 to 6 inches thick, usually very dark grayish brown in color, and predominantly of a moderate, fine, granular structure. Many have an A_3 horizon in which organic staining extends to a depth of about 10 inches. Most have prominent layers of accumulated calcium carbonate in the lower part of the B or the upper part of the C horizon. Mixed with the mountain bunchgrass is considerable sagebrush, which is believed to be an invader.

The soils that developed under pinyon and juniper have an A horizon much the same in color and structure as that of soils under mountain bunchgrass, but somewhat less thick. Except where the parent material was limestone residuum, there is no layer of accumulated calcium carbonate.

The soils that developed under coniferous forest have thin A_1 and A_2 horizons and a thick B horizon. The A_1 horizon is lighter colored, thinner, and lower in organic matter than that of the soils that formed under mountain bunchgrass or under pinyon and juniper. The A_2 horizon is generally about 6 inches thick. Except where the parent material was limestone residuum, there is no layer of accumulated calcium carbonate.

Climate

A number of microclimates exist in the watershed because of differences in elevation and aspect.

Elevations range from 8,410 to 10,830 feet. Although this is not a wide range for a mountainous area, the resulting range in climate is sufficient to cause vertical zonation of vegetation and of kinds of soils (see Vegetation).

The influence of aspect is conspicuous. West-facing and south-facing slopes, which are more exposed to the sun, are drier and warmer than east-facing and north-facing slopes. The soils on the south-facing slopes are mostly Chestnut soils or Chestnut-Chernozem intergrades; at the higher elevations, they grade toward Gray Wooded soils. The north-facing slopes are cooler, moister, and more densely vegetated. The soils on the north-facing slopes are Gray Wooded soils that grade at higher elevations toward Podzols and at lower elevations toward Chernozems.

The soils in the watershed are not deeply leached, because they are frozen for a long time each year and during the time they are not frozen there is little precipitation. The depth to the more or less unweathered parent material ranges from 20 to 36 inches, depending upon the relief. The reaction varies surprisingly little from place to place. The pH ranges from 6.4 (slightly acid) to 7.0 (neutral) and is commonly about 6.8.

Time

Time is an important factor in the formation of parent material and is necessary for the development of soils. Its effectiveness as a soil-forming factor depends, to a considerable degree, on the influence exerted by climate and living organisms and the modifying effects of relief and parent material. Because of the interrelationships of the five factors of soil formation, the effect of time has, of necessity, been covered to some extent in the discussion of the other four factors.

The age of a soil is determined by the depth, the degree of horizonation, and the intensity of weathering or leaching. Mature soil characteristics may develop in a relatively short time if all factors are favorable to intense weathering and leaching. If one or more factors have significant modifying effects, a long time may be required. Many of the soils on steep slopes are young, or immature, because erosion is continually removing the developed surface layer and bringing fresh parent material to the surface. Alluvial land is young because of the almost continuous accumulation of fresh material.

Chronological age is not the vital consideration. For example, the steep uplands have Regosols on the southerly exposures and Gray Wooded soils on the northerly exposures. Although the ages, in terms of years, are the same, the Regosols are young in terms of soil development, but the Gray Wooded soils are approaching maturity.

Classification of Soils

The soils of Trout Creek Watershed represent five great soil groups—Brown soils, Chestnut soils, Gray Wooded soils, Lithosols, and Regosols—and two soil orders—the zonal and the azonal. The relation between the series, the great soil groups, and the orders is shown in table 5.

TABLE 5.—*Classification of soils*

Order	Suborder	Great soil group	Series
Zonal	Light-colored soils of arid regions.	Brown soils	Garo.
	Dark-colored soils of semiarid, subhumid, and humid grasslands.	Chestnut soils	Bassel. Buena Vista. Heath. Nathrop. Trout Creek. Wellsville.
	Light-colored podzolized soils of timbered regions.	Gray Wooded soils.	Chubbs. Edloe.
Azonal	None	Lithosols	Laporte. Trump.
		Regosols	Stecum.

Zonal order

Zonal soils generally have well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms, chiefly vegetation (*11*)—but some of the zonal soils in Trout Creek Watershed are but weakly developed. Three of the great soil groups represented in the watershed are in the zonal order—the Brown soils, the Chestnut soils, and the Gray Wooded soils.

BROWN SOILS

Brown soils develop in a temperate or cool, semiarid climate, under native vegetation of short grasses, bunchgrasses, and shrubs. They have a brown surface soil.

The subsoil grades, at depths of 1 to 2 feet, into a light-gray or white calcareous layer (*11*).

Garo series.—The Garo series is the only representative of the Brown great soil group in Trout Creek Watershed. It consists of well-drained, moderately fine textured soils that have developed in material weathered from calcareous, weakly metamorphosed Pennsylvanian shale and interbedded sandstone. These soils are characterized by a dark-colored A horizon, a weak A_1 horizon, a B horizon with slight clay accumulation, and, if any, a very weak horizon of lime accumulation. They occur at an elevation of about 9,500 feet, on southerly exposures. The relief ranges from gently rolling to strongly sloping. The annual precipitation is between 12 and 14 inches, and the average annual temperature is about 42° F.

Associated with the Garo soils are the Heath and Trout Creek soils, which have developed from similar parent material but are in the Chestnut great soil group. The Garo soils differ from the Trout Creek soils in having a thinner and paler A_1 horizon and in being more uniformly gray.

A typical profile of Garo clay loam on a moderate slope is described as follows:

A_1 0 to 2 inches, grayish-brown (2.5Y 5/2, dry) to dark grayish-brown (2.5Y 4/2, moist) light clay loam; weak, fine, subangular blocky structure that breaks to moderate to strong, very fine granules; soft when dry, very friable when moist; noncalcareous, pH approximately 6.8; lower boundary clear and smooth.

A_3 2 to 3½ inches, olive or light olive-brown (2.5Y 4.5/3, dry) to olive-brown (2.5Y 4/3, moist) light clay loam; strong, fine and very fine, granular structure; soft when dry, very friable when moist; noncalcareous, pH approximately 7.0; lower boundary clear and smooth.

B_2 3½ to 8 inches, olive-brown or light olive-brown (2.5Y 4.5/3, dry) to olive-brown (2.5Y 4/3, moist) heavy clay loam; moderate, fine, subangular blocky structure breaking to moderate, fine, angular blocks; hard when dry, friable when moist; noncalcareous, pH approximately 7.0; thin, patchy clayskins on both horizontal and vertical faces of soil aggregates; many shale and sandstone fragments; lower boundary diffuse and smooth.

C 8 to 18 inches, olive-brown (2.5Y 4/3, dry) to very dark grayish-brown (2.5Y 3/2, moist) partly weathered fine sandy shale and interbedded sandstone.

In many places, the Garo soils have a surface soil and subsoil of silty clay loam and a zone of calcium carbonate accumulation, as in the following profile:

A_1 0 to 3 inches, grayish-brown (1.25Y 5/2, dry) to very dark grayish-brown (1.25Y 3/2, moist) light silty clay loam; moderate, fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous, pH approximately 6.6; lower boundary gradual and smooth; horizon is 2 to 4 inches thick.

B_2 3 to 9 inches, gray or dark gray (1.25Y 4.5/1, dry) to very dark gray or very dark grayish-brown (1.25Y 3/1.5, moist) heavy silty clay loam; weak to moderate, medium, prismatic structure breaking to moderate, fine, subangular blocks; slightly hard when dry, very friable when moist; noncalcareous, pH approximately 7.0; moderate continuous clayskins on faces of soil aggregates; lower boundary gradual and smooth; horizon is 5 to 10 inches thick.

C_{ca} 9 to 13 inches, gray (1.25Y 5/1, dry) to very dark gray (1.25Y 3/1, moist) silty clay loam; moderate to strong, medium, platy structure breaking to strong, fine plates; slightly hard when dry, very friable when moist; strongly calcareous; a weak horizon of lime accumulation, with some visible lime occurring as thin seams and streaks; structure largely inherited from that of the underlying parent rock; lower boundary gradual and smooth; horizon is 4 to 8 inches thick.

D_r 13 to 19 inches, dark gray (2.5Y 4/1, dry) to very dark gray (2.5Y 3/1, moist) partly weathered, platy, weakly metamorphosed shale and interbedded sandstone; several feet thick.

The principal variations are in the color, thickness, and texture of the individual horizons. The degree of development of the B horizon varies, but in all places there is sufficient clay to form a definite B horizon. Although the A_1 horizon in the profile described is dark colored, there is not a strong contrast between it and the C horizon. In some places, the profile is calcareous at the surface.

CHESTNUT SOILS

Chestnut soils are characterized by a dark-brown or dark grayish-brown surface soil that grades into a light-gray or white calcareous horizon at depths of 1½ to 2 feet. These soils develop in temperate to cool, semiarid regions, under a mixture of short and tall grasses (*11*). In mountainous areas, vegetational zones are not always distinct. In Trout Creek Watershed, the Chestnut soils, in many places, have scattered pinyon, juniper, and ponderosa pine trees mixed with the grasses.

The Chestnut great soil group is represented in Trout Creek Watershed by the Buena Vista, Bassel, Heath, Wellsville, Nathrop, and Trout Creek series. The Bassel, Heath, and Wellsville soils have developed in old colluvial-alluvial deposits. The parent material of the Bassel soils is dominantly granitic; that of the Heath and Trout Creek soils is dominantly shale; and that of the Wellsville is a mixture of granite, limestone, and shale. The Nathrop soils, which occur only in a complex with Trump and Laporte soils, have developed in limestone residuum, and the Buena Vista soils in residuum weathered from trachyte tuff.

All of the Chestnut soils have certain characteristics in common. The sequence of major horizons is the same, except that the Nathrop soils lack the transitional A_3 or B_1 horizon common to the other soils in this group.

Bassel series.—The Bassel soils have a dark-colored A horizon, a B_2 horizon having a distinct accumulation of clay, and a moderate to prominent horizon of lime accumulation. They have developed in old, valley-filling sediments that are coarse textured to moderately coarse textured and calcareous. In places these soils occupy benchlike formations that may be remnants of old high terraces. The soils occur in mountain valleys and, in Trout Creek Watershed, are at elevations of 8,500 to 9,000 feet. The average annual precipitation is 15 inches; the average annual temperature is about 42° F. The average summer temperature is 60° F. The relief is gently sloping to sloping.

Associated with the Bassel soils in this area are the Stecum soils, which are Regosols that have developed in residuum weathered from granite. The Wellsville soils, which, like the Bassel soils, have developed from valley-filling sediments, are finer textured than the Bassel soils.

A typical profile of Bassel gravelly sandy loam in a gently sloping site is described as follows:

A_1 0 to 4 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) gravelly sandy loam; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; approximately 10 percent of this horizon is fine

gravel; because of differential erosion, gravel is concentrated at the surface; lower boundary clear and smooth; horizon is 3 to 6 inches thick.

A_3 4 to 7 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) gravelly sandy loam; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocks; slightly hard when dry, very friable when moist; noncalcareous; a few thin, patchy clayskins on both horizontal and vertical faces of soil aggregates; approximately 15 percent of this horizon is water-worn gravel; lower boundary gradual and smooth; horizon is 2 to 4 inches thick.

B_2 7 to 15 inches, brown (10YR 5/3, dry) to brown or dark-brown (10YR 4/3, moist) gravelly sandy clay loam; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocks; hard when dry, friable when moist; noncalcareous; thin, nearly continuous clayskins on surfaces of soil aggregates; about 15 percent of this horizon is gravel; lower boundary gradual and smooth; horizon is 5 to 10 inches thick.

B_{3ca} 15 to 21 inches, pale-brown (10YR 6/3, dry) to brown (10YR 5/3, moist) gravelly light sandy clay loam; weak, medium, prismatic structure breaking to weak, medium, subangular blocks; hard when dry, friable when moist; strongly calcareous; a few thin, patchy clayskins on both horizontal and vertical faces of soil aggregates; this is a weak horizon of lime accumulation, with some visible lime in the form of small, soft concretions; about 25 percent of this horizon is gravel; lower boundary gradual and smooth; horizon is 4 to 8 inches thick.

C_{ca} 21 to 32 inches, very pale brown (10YR 7/3, dry) to pale brown (10YR 6/3, moist) gravelly sandy loam; massive; slightly hard when dry, very friable when moist; violently calcareous; this is a strong or moderate horizon of lime accumulation, with visible lime in soft concretions and in finely divided forms; about 30 percent of this horizon is gravel; lower boundary diffuse and smooth; horizon is 8 to 15 inches thick.

C 32 to 60 inches +, pale-brown (10YR 6/3, dry) to yellowish-brown (10YR 5/4, moist) gravelly loamy sand or sandy loam; single grained; slightly hard when dry, very friable when moist; violently calcareous; this is a weak horizon of lime accumulation that contains some visible lime in the form of soft concretions approximately one-quarter inch in diameter, but there is less lime in this horizon than in the C_{ca} horizon; approximately 40 to 50 percent of this horizon is gravel; horizon is several feet thick.

Generally the horizons of lime accumulation are strongly developed, but in places they are only moderately developed. In some sites the content of gravel is less than in the profile described.

Wellsville series.—The Wellsville series consists of well-drained, moderately fine textured soils that have developed in calcareous, medium textured to moderately fine textured, locally transported valley-filling materials derived from trachyte, limestone, and shale. These soils have a dark-colored A horizon, a B_2 horizon having a distinct accumulation of clay, and a weak horizon of lime accumulation. In sequence of horizons and in depth to the accumulation of lime, the profile closely resembles that of the Bassel soils, but the Wellsville soils are finer textured than the Bassel soils because they have developed from finer textured parent material. The Wellsville soils in Trout Creek Watershed occupy gently to strongly sloping relief at an elevation of about 9,000 feet. A profile of Wellsville very fine sandy loam on a moderate slope is described as follows:

A_1 0 to 4 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) very fine sandy loam; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; lower boundary clear and smooth; horizon is 4 to 6 inches thick.

B_1 4 to 7 inches, brown (7.5YR 5/3, dry) to dark-brown (7.5YR 3/3, moist) clay loam; weak to moderate, medium, prismatic structure breaking to moderate, medium, subangular blocks; slightly hard when dry, very friable when moist; noncalcareous; lower boundary clear and smooth; horizon is 2 to 4 inches thick.

B_2 7 to 15 inches, brown (7.5YR 5/4, dry) to brown or dark-brown (7.5YR 4/3, moist) clay loam; weak to moderate, medium, prismatic structure breaking to weak to moderate, medium, subangular blocks; hard when dry, friable when moist; noncalcareous; moderately thick, nearly continuous clayskins on surfaces of soil aggregates; lower boundary gradual and wavy; horizon is 7 to 12 inches thick.

B_{3ca} 15 to 19 inches, brown (10YR 5/3, dry) to brown or dark-brown (10YR 4/3, moist) heavy loam; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; this is a weak horizon of lime accumulation and contains some visible lime in the form of concretions and coatings on the coarser fragments of sand and gravel; a few thin, patchy clayskins on both horizontal and vertical faces of aggregates; lower boundary gradual and smooth; horizon is 3 to 6 inches thick.

C_{ca} 19 to 21 inches, light-gray (10YR 7/2, dry) to grayish-brown or brown (10YR 5/2.5, moist) channery clay loam; massive to single grained; slightly hard when dry, very friable when moist; violently calcareous; this is a moderate horizon of lime accumulation; visible lime occurs mostly in finely divided forms; about 25 percent of this horizon is shale and limestone fragments; lower boundary gradual and smooth; horizon is 6 to 12 inches thick.

C 21 to 60 inches +, light-gray (2.5YR 7/2, dry) to grayish-brown (2.5Y 5/2, moist) light clay loam; massive; hard when dry, very friable when moist; violently calcareous; contains some accumulated calcium carbonate but less than the C_{ca} horizon; contains a moderate amount of small and medium-sized fragments of limestone and shale, as well as rounded granitic gravel and some pebbles of trachyte and tuff.

Buena Vista series.—The Buena Vista series consists of well-drained, medium textured to moderately fine textured, weakly developed soils that have developed in residuum weathered from trachyte and tuff. Like the other Chestnut soils, they are characterized by a dark-colored A horizon, a B_2 horizon having a distinct accumulation of clay, and a weak to prominent horizon of lime accumulation. The Buena Vista soils have a weaker textural B horizon than the other soils. They occupy southerly exposures in the uplands. The relief is undulating to strongly rolling. The annual precipitation is about 12 inches, and the average annual temperature is about 42° F. A typical profile of Buena Vista very stony sandy loam on a rolling site is described as follows:

A_1 0 to 3 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) very stony sandy loam; strong, very fine, granular structure; soft when dry, very friable when moist; noncalcareous, pH approximately 6.4; 20 percent or more of this horizon is stone or gravel; lower boundary clear and smooth; horizon is 3 to 5 inches thick.

A_3 3 to 10 inches, brown (10YR 5/3, dry) to dark-brown (10YR 3/3, moist) stony sandy loam; weak to moderate, medium, subangular blocky structure breaking to moderate, medium granules; slightly hard when dry, very friable when moist; noncalcareous, pH approximately 6.8; approximately 50 percent of this horizon is stone; lower boundary clear and smooth; horizon is 6 to 8 inches thick.

B_2 10 to 16 inches, brown or pale-brown (10YR 5.5/3, dry) to dark-brown (10YR 3.5/3, moist) stony sandy clay

loam; moderate, fine, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous, pH approximately 7.2; thin, patchy clayskins on both horizontal and vertical faces of soil aggregates; thin, nearly continuous clay coatings on some of the rock fragments; approximately 50 percent of this horizon is stone; lower boundary gradual and smooth; horizon is 5 to 10 inches thick.

B_{3ca} 16 to 20 inches, pale-brown (10YR 6/3, dry) to brown or dark-brown (10YR 4/3, moist) stony sandy loam; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; violently calcareous; this is a weak horizon of lime accumulation; visible lime occurs in concretions and in finely divided forms; approximately 50 percent of this horizon is stone; lower boundary gradual and smooth; horizon is 3 to 5 inches thick.

C_{ca} 20 to 35 inches +, light-gray (2.5Y 7/1, dry) to gray or grayish-brown (2.5Y 5/1.5, moist) stony sandy loam; massive; slightly hard when dry, very friable when moist; violently calcareous; this is a prominent horizon of lime accumulation; visible lime occurs in finely divided forms, as soft concretions, and as coatings on the stone fragments; approximately 70 to 80 percent of this horizon is stone; horizon is 10 to 20 inches thick; it grades downward into unweathered or only weakly weathered trachyte bedrock.

The texture of the B horizon is modally a sandy clay loam but ranges from a sandy loam or loam to a clay loam that is about 30 percent clay. In places where the soil has been subjected to ground water high in calcium, the profile is weakly calcareous throughout. In places, mostly where the percentage of stones is very high, the depth to the calcareous layers is greater than in the modal profile.

Nathrop series.—The Nathrop series consists of well-drained, weakly developed soils that have developed in medium-textured, calcareous residuum weathered from Pennsylvanian limestone. They are characterized by a dark-colored A horizon, a B_2 horizon having a distinct accumulation of clay, and a weak to prominent horizon of lime accumulation. These soils are found in close association with Laporte, Trump, and Chubbs soils. They occupy southerly exposures in the uplands. The relief is gently rolling to steeply sloping. The climate and vegetation are generally the same as for the other Chestnut soils in the watershed. A typical profile of Nathrop loam is described as follows:

A_1 0 to 4 inches, brown or grayish-brown (8.75YR 5/2, dry) to dark-brown or dark grayish-brown (8.75YR 3/2, moist) loam; weak, fine subangular blocky structure breaking to moderate, fine granules; soft when dry, very friable when moist; noncalcareous; lower boundary clear and smooth; horizon is 3 to 5 inches thick.

B_2 4 to 9 inches, brown or reddish-brown (6.75YR 5/3, dry) to dark-brown or dark reddish-brown (6.75YR 3.5/3, moist) clay loam; weak, medium, prismatic structure breaking to weak to moderate, medium, subangular blocks; slightly hard when dry, very friable when moist; noncalcareous; moderate, patchy clayskins on both horizontal and vertical faces of aggregates; approximately 10 percent of this horizon is gravel; lower boundary clear and smooth; horizon is 5 to 10 inches thick.

B_{3ca} 9 to 13 inches, brown (7.5YR 5/3, dry) to brown or dark-brown (7.5YR 4/3, moist) gravelly loam; weak, fine, subangular blocky structure breaking to moderate, fine granules; slightly hard when dry, very friable when moist; calcareous; this is a weak horizon of lime accumulation; visible lime occurs principally as coatings on the underside of the gravel fragments; a few thin, patchy clayskins, principally on vertical faces of aggregates; approximately 40 percent of this horizon is gravel; lower boundary gradual and smooth; horizon is 2 to 4 inches thick.

C_{ca} 13 to 19 inches, white (10YR 8/2, dry) to light brownish-gray or pale-brown (10YR 6/2.5, moist) gravelly loam; massive to very weak, fine, granular structure; slightly hard when dry, very friable when moist; violently calcareous; this is a prominent horizon of lime accumulation; visible lime occurs in finely divided forms; lower boundary gradual and smooth; horizon is 3 to 6 inches thick.

D 19 to 26 inches +, partly weathered and fractured Pennsylvanian limestone bedrock.

Heath series.—Heath clay loam has developed in valley-filling materials derived mostly from shale. The following profile is on a 4 percent east-facing slope at an elevation of 9,000 feet. The vegetative cover consists of broom snakeweed, ring muhly, and some blue grama.

A_1 0 to 2 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/1.5, moist) clay loam; moderate, very fine, granular structure; soft when dry, very friable when moist; noncalcareous; lower boundary clear and smooth.

A_3 2 to 5 inches, very dark grayish-brown or dark grayish-brown (10YR 3.5/2, dry) to very dark brown (10YR 2/2, moist) heavy loam or light clay loam; weak to moderate, fine, subangular blocky structure breaking to moderate, fine granules; slightly hard when dry, very friable when moist; noncalcareous; a few thin, patchy clayskins, principally on vertical faces of aggregates; lower boundary clear and smooth.

B_2 5 to 9 inches, very dark grayish-brown or dark grayish-brown (10YR 3.5/2, dry) to very dark brown or very dark grayish-brown (10YR 2.5/2, moist) clay loam; weak to moderate, fine, prismatic structure breaking to moderate, fine, subangular blocks; hard when dry, very friable when moist; noncalcareous; thin to medium, patchy clayskins on both horizontal and vertical faces of most of the aggregates; lower boundary gradual and smooth.

B_{3ca} 9 to 13 inches, grayish-brown (2.5Y 5/2, dry) to dark grayish-brown (2.5Y 4/2, moist) heavy loam or light clay loam; weak to moderate, fine, prismatic structure breaking to moderate, fine, subangular blocks; hard when dry, very friable when moist; violently calcareous; this is a weak horizon of lime accumulation; some visible lime occurs as concretions; thin, patchy clayskins, principally on vertical faces of some of the aggregates; lower boundary gradual and smooth.

C_{ca} 13 to 28 inches, light brownish-gray (2.5Y 6/2, dry) to dark grayish-brown or grayish-brown (2.5Y 4.5/2, moist) gravelly loam; massive or very weak, fine, subangular blocky structure; hard when dry, very friable when moist; violently calcareous; this is a moderate horizon of lime accumulation; visible lime occurs as concretions, as thin seams and streaks, or as coatings on the surface of the rock and gravel; approximately 25 percent of this horizon is cobblestones and gravel; lower boundary diffuse and smooth.

C 28 to 39 inches +, light olive-brown (2.5Y 5/3, dry) to olive-brown (2.5Y 4/3, moist) gravelly clay loam; massive; hard when dry, very friable when moist; violently calcareous; contains some accumulated calcium carbonate but less than the C_{ca} horizon; approximately 15 percent of this horizon is gravel and stones.

Trout Creek series.—The Trout Creek series consists of well-drained, moderately fine textured to fine textured soils that have developed in calcareous material weathered from interbedded, weakly metamorphosed Pennsylvanian shale, sandstone, and limestone. The soils are characterized by a dark-colored A horizon, a B_2 horizon having a distinct accumulation of clay, a weak to prominent horizon of lime accumulation, and variegated coloration. Although derived predominantly from shale, the parent

material includes enough sandstone and limestone material to affect morphology. The relief is undulating to rolling. The annual precipitation is about 12 to 14 inches. The average annual temperature at the nearest weather station is about 42° F., but on the north-facing slopes where the Trout Creek soils occur it is a little lower.

Associated with the Trout Creek soils are the Garo soils, which have developed in similar parent material but are in the Brown great soil group. The Trout Creek soils have a thicker A_1 horizon than the Garo soils, and they are redder and less uniform in color.

Although classified as Chestnut soils, the Trout Creek soils in this area grade slightly toward the Chernozems. A typical profile on a rolling site is described as follows:

A_1 0 to 4 inches, brown or dark-brown (7.5YR 4/2, dry) to very dark gray (7.5YR 3/1, moist) clay loam; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; lower boundary clear and smooth; horizon is 3 to 6 inches thick.

A_3 4 to 7 inches, clay loam of strongly variegated brown (7.5YR 4/2, dry) or light brown (7.5YR 6/4, dry) to dark brown (7.5YR 3/2, moist) or brown (7.5YR 5/4, moist); strong, very fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous; a few thin, patchy clayskins, principally on vertical faces of aggregates; approximately 5 percent of this horizon is channery fragments and gravel; lower boundary clear and smooth; horizon is 3 to 5 inches thick.

B_2 7 to 14 inches, clay; moderately variegated colors similar to those of the A_3 horizon, but predominantly brown (7.5YR 5/3, dry) to brown or dark brown (7.5YR 4/3, moist); strong, very fine, subangular blocky structure; hard when dry, very friable when moist; noncalcareous; thin, nearly continuous clayskins on surfaces of aggregates; approximately 5 percent of this horizon is channery fragments of sandstone and limestone; lower boundary clear and smooth; horizon is 5 to 10 inches thick.

B_{3ca} 14 to 17 inches, grayish-brown (2.5Y 5/2, dry) to dark grayish-brown (2.5Y 4/2, moist) clay loam; moderate, fine, subangular blocky structure; hard when dry, very friable when moist; calcareous; this a weak horizon of lime accumulation; some visible lime occurs as soft concretions; a few very thin, patchy clayskins on faces of aggregates; lower boundary gradual and smooth; horizon is 2 to 4 inches thick.

C_{ca} 17 to 22 inches, light-gray (2.5Y 7/1, dry) to dark grayish-brown or grayish-brown (2.5Y 4.5/2, moist) clay loam; moderate, fine, subangular blocky structure; hard when dry, very friable when moist; calcareous; this is a prominent horizon of lime accumulation; visible lime occurs in soft concretions and in finely divided forms; lower boundary gradual and smooth; horizon is 4 to 7 inches thick.

D_r 22 to 25 inches +, light yellowish-brown (2.5Y 6/3, dry) to olive-brown (2.5Y 4.5/3, moist) partly weathered shale and interbedded sandstone; calcareous; several feet thick.

The principal variations are in the color, thickness, and texture of the horizons. The color of the A_1, A_3, and B horizons is extremely variable and is largely dependent upon the influence of the sandstone and limestone in the parent material. The texture of the B horizon is modally a clay but may be a clay loam to silty clay loam in places.

GRAY WOODED SOILS

Gray Wooded soils develop in a subhumid to semiarid, cool, mesothermal to microthermal climate under a cover of coniferous, deciduous, or mixed forest. In color, the profiles resemble those of Podzols, except that the B horizon is generally lower in chroma. The A_2 horizon is about twice as thick as that of most Podzols in North America, and the B horizon is higher in clay than that of Podzols. The parent material is calcareous; it ranges in reaction from neutral to medium acid. Many soils of this group have a horizon of calcium carbonate accumulation below the B_2 horizon. A strongly acid reaction is exceptional (*10*).

In Trout Creek Watershed, the Edloe and Chubbs series represent the Gray Wooded great soil group.

Edloe series.—The Edloe soils have developed in products weathered from granite in which some gneiss and biotite schist are included. They occupy north-facing slopes in the uplands at elevations of 9,000 to 10,000 feet. The vegetation is a forest of spruce and Douglas-fir. The relief ranges from rolling to steep. The annual precipitation is 12 to 14 inches. Since these soils are on north-facing slopes, it is probable that the average annual temperature is lower than that recorded at the nearest weather station, which is about 42° F. A typical profile of Edloe gravelly sandy loam at an elevation of 9,855 feet on a slope of about 42 percent is described as follows:

A_{00}, A_0 1 to 0 inch, an organic horizon made up of undecomposed and partly decomposed organic matter, principally pine needles, bark, branches, and woody plant remains; rests abruptly on the A_1 horizon.

A_1 0 to 2 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) gravelly sandy loam; moderate, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; approximately 25 percent of this horizon is gravel; lower boundary abrupt and smooth.

A_2 2 to 8 inches, light-gray (10YR 7/2, dry) to grayish-brown (10YR 5/2, moist) gravelly loamy sand; weak, fine, platy structure breaking to moderate fine crumbs; soft when dry, very friable when moist; noncalcareous; few, small, distinct, 10YR 5/4 mottles; approximately 40 percent of this horizon is gravel; lower boundary gradual and wavy.

B_1 8 to 13 inches, very pale brown (10YR 7/3, dry) to brown (10YR 5/3, moist) gravelly sandy loam or gravelly loamy sand; weak, medium, subangular blocky structure breaking to moderate, fine granules; soft when dry, very friable when moist; noncalcareous; contains aggregates similar to those in the B_2 horizon that are thoroughly imbedded in a light-colored material similar to that of the A_2 horizon; color and texture vary, depending upon the amount of such aggregates; approximately 40 percent of the horizon is gravel; lower boundary gradual and wavy.

B_2 13 to 18 inches, pale-brown (10YR 6/3, dry) to brown or dark-brown (10YR 4/3, moist) stony sandy clay loam; moderate, medium, subangular blocky structure; hard when dry, friable when moist; noncalcareous; thin, nearly continuous clayskins on surfaces of aggregates and coating the rocks; in some parts of the horizon, seams of fine-textured clayey material approximately an eighth of an inch thick occur between the aggregates; approximately 65 percent of the horizon is stone; lower boundary diffuse and irregular.

D_r 18 to 34 inches, weathered granite rock that includes some biotite schist; weathering has proceeded so that the rocks generally may be crushed between the fingers; some evidence of clay movement extends into this horizon, but, because of the nature of the horizon, it is not possible to determine where the clay movement ceases.

The pH ranges from 6.1 to 6.8. The thickness of the A_2 horizon ranges from about 6 to 10 inches.

The Edloe soils reflect the effects of climate and vegetation to a greater degree than any of the other soils in the

watershed. They are on cool, north-facing slopes where evaporation is less rapid than in other locations; consequently, more moisture is absorbed, leaching has had more effect, and the vegetative cover is more dense.

Chubbs series.—The Chubbs soils are members of the Gray Wooded great soil group. They are well-drained soils that have developed under forest vegetation in residuum weathered from Pennsylvanian limestone. They are normally characterized by a thin A_1 horizon, a thin, weakly developed A_2 horizon, a B_2 horizon having a distinct accumulation of clay, and a weak to prominent horizon of lime accumulation. Generally they are calcareous below a depth of 13 or 14 inches and neutral to slightly acid in the upper horizons. These soils are in an area having an average annual rainfall of about 12 inches, an average annual temperature of about 42° F., and a calculated precipitation effectiveness index (*9*) of 26.2. Since the Chubbs soils occur only on north-facing slopes, it is estimated that their average annual soil temperature is less than 42° F. The relief is moderately to steeply sloping.

Associated with the Chubbs soils are the Nathrop and Trump soils, which have developed from the same kind of parent material but on south-facing slopes. The Chubbs soils differ from the Nathrop soils, which are Chestnut soils formed in material weathered from limestone, in having a thinner A horizon and in having a weak A_2 horizon. They differ from the Trump soils, which are Lithosols with a color B horizon, in having an A_2 horizon and a B_2 horizon having a distinct accumulation of clay. A typical profile of Chubbs clay loam on an 8 percent, convex, north-facing slope, under a cover of spruce, Douglas-fir, and quaking aspen, is described as follows:

A_0, A_{00} ½ to 0 inch, an organic horizon made up of undecomposed and partly decomposed forest residues, mainly pine needles, bark, and woody branches.

A_1 0 to 2 inches, dark-gray (10YR 4/1, dry) to very dark grayish-brown (10YR 3/2, moist) loam; moderate, fine, crumb structure; soft when dry, very friable when moist; noncalcareous, pH approximately 6.8; lower boundary abrupt and smooth; horizon is 0 to 3 inches thick.

A_2 2 to 3 inches, pink (7.5YR 7/4, dry) to brown (7.5YR 5/3, moist) gravelly loam; weak to moderate, fine, platy structure; soft when dry, very friable when moist; noncalcareous, pH approximately 7.0; soil aggregates have a vesicular appearance; lower boundary abrupt and smooth; horizon is ½ to 2 inches thick.

B_2 3 to 10 inches, brown (7.5YR 5/4, dry) to brown or dark-brown (7.5YR 4/4, moist) stony clay loam; moderate, medium and fine, subangular blocky structure; hard when dry, very friable when moist; noncalcareous; pH approximately 7.4; medium, continuous clayskins on surfaces of aggregates, and thin coatings of clay on the rock fragments; approximately 40 percent of this horizon is stone; lower boundary gradual and irregular; horizon is 6 to 10 inches thick.

B_3 10 to 15 inches, brown (10YR 5/3, dry) to brown or dark-brown (10YR 4/3, moist) stony light clay loam; weak to moderate, fine, subangular blocky structure breaking to moderate, fine granules; hard when dry, very friable when moist; calcareous; this is a weak horizon of lime accumulation; some visible lime occurs as coatings on the rock fragments; a few thin, patchy clayskins on both horizontal and vertical faces of aggregates and on faces of stones; approximately 40 percent of this horizon is stone; lower boundary gradual and smooth; horizon is 4 to 6 inches thick.

C_{ca} 15 to 19 inches, gray or light-gray (10YR 5.5/1, dry) to dark grayish-brown or grayish-brown (10YR 4.5/2, moist) stony loam; weak to moderate, fine, crumb structure; slightly hard when dry, very friable when moist; violently calcareous; this is a moderate horizon of lime accumulation; visible lime occurs in finely divided forms and in soft concretions; approximately 50 percent of this horizon is stone; lower boundary gradual and smooth; horizon is 6 to 8 inches thick.

D 19 to 25 inches +, fractured limestone of Pennsylvanian age; several feet thick.

Azonal order

Azonal soils are without well-developed soil characteristics, either because of their youth or because the nature of the parent material or the relief have prevented the development of definite soil characteristics (*11*). The azonal order is represented in Trout Creek Watershed by the Laporte and Trump soils, which are Lithosols, and by the Stecum soils, which are Regosols.

LITHOSOLS

The Lithosols are azonal soils having an incomplete solum or no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of hard rock or hard rock fragments. They are confined largely to steeply sloping land (*11*).

Laporte series.—The Laporte soils occur in close association with the Trump and Nathrop soils. They have developed from Pennsylvanian limestone under mixed grass-tree vegetation. The annual precipitation is about 12 inches, and the average annual temperature is about 42° F. The following profile of Laporte gravelly sandy loam is on a convex, south-facing, upland slope of 30 percent gradient. The drainage is good. The vegetation is mainly Arizona fescue and muhly but includes some pine and scattered spruce trees.

A_{11} 0 to 3 inches, gray or grayish-brown (10YR 5/1.5, dry) to very dark grayish-brown (10YR 3/2, moist) gravelly sandy loam; moderate, fine, granular structure; soft when dry, very friable when moist; violently calcareous; approximately 25 percent of this horizon is gravel; lower boundary clear and smooth.

A_{12} 3 to 7 inches, grayish-brown (10YR 5/2, dry) to very dark gray or dark grayish-brown (10YR 3/1.5, moist) gravelly sandy loam; weak, fine, subangular blocky structure breaking to moderate, fine crumbs; soft when dry, very friable when moist; violently calcareous; approximately 25 percent of this horizon is gravel; lower boundary gradual and smooth.

A_{13} 7 to 12 inches, gray or light-gray (10YR 5.5/1, dry) to very dark grayish-brown (10YR 3/2, moist) gravelly sandy loam or light gravelly loam; weak, fine, subangular blocky structure breaking to moderate, fine crumbs; soft when dry, very friable when moist; violently calcareous; this is a weak horizon of lime accumulation; visible lime occurs principally in the form of soft concretions; approximately 50 percent of this horizon is gravel; lower boundary gradual and smooth.

C_{ca} 12 to 21 inches, light-gray (10YR 6/1, dry) to dark grayish-brown or brown (10YR 4.5/2.5, moist) stony sandy loam; massive; soft when dry, very friable when moist; violently calcareous; this is a prominent horizon of lime accumulation; visible lime occurs in finely divided forms; approximately 50 percent of this horizon is stone; lower boundary gradual and smooth.

D 21 inches +, partly weathered and fractured Pennsylvanian limestone bedrock.

The principal variation is in the depth to the bedrock. In some places the bedrock is exposed, and in others it is at depths ranging up to 25 inches.

Trump series.—The Trump series consists of shallow, well-drained, medium-textured soils that have developed from Pennsylvanian limestone under mixed grass-tree vegetation. The soils are generally not more than 18 inches thick and are characterized by a dark-colored A horizon and a color B horizon. They occupy southerly exposures in the uplands on moderately to steeply sloping relief. The annual precipitation is about 12 inches, the average annual temperature is about 42° F., and the calculated precipitation effectiveness index (*9*) is 26.2. The Trump soils occur in close association with the Laporte soils. They differ from the Laporte soils in having a distinct color B horizon. Following is a description of a typical profile of Trump loam on a 15 percent, southwest-facing slope. The vegetation consists of ring muhly, Arizona fescue, Thurber's fescue, and scattered pine and spruce trees.

A_1 0 to 4 inches, gray (10YR 5/1, dry) to very dark gray (10YR 3/1, moist) loam; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; lower boundary clear and smooth; horizon is 3 to 6 inches thick.

B 4 to 8 inches, brown (7.5YR 5/2, dry) to dark-brown (7.5YR 3.5/2, moist) loam; weak to moderate, fine, subangular blocky structure breaking to moderate, fine granules; slightly hard when dry, very friable when moist; noncalcareous; lower boundary abrupt and smooth; horizon is 4 to 8 inches thick.

D 8 inches +, pale-brown (10YR 6/2, dry) to dark grayish-brown (10YR 4/2, moist), hard, partly weathered and fractured Pennsylvanian limestone bedrock; several feet thick.

The principal variations are in the color, thickness, and texture of the individual horizons and in the depth of the soil over bedrock. The color of the A_1 horizon is modally as described above, but it ranges in hue from 1.25Y to 7.5YR, in chroma from neutral to 2, and in value from 4 to 5.5 when dry and 2 to 3.5 when moist. The color of the B horizon is sufficiently different in hue and chroma to justify a color B. The texture of the B horizon is modally a loam, but it ranges from a light loam to a clay loam that is 32 percent clay. The thickness of the soil over bedrock ranges from 8 to 20 inches.

REGOSOLS

Regosols are azonal soils that lack definite genetic horizons. They are developing from deep, soft mineral deposits, such as loess or glacial drift. The Stecum soils are the only Regosols, and the most extensive azonal soils, in Trout Creek Watershed.

Stecum series.—The Stecum soils have developed in unconsolidated material weathered in place from granite and in accumulations of locally transported granitic material (fig. 7). Inclusions of gneiss and biotite schist have also contributed to the parent material. These soils are on rolling to steep, south-facing slopes in the uplands. Because of the strong slopes, they are affected by creep and by geologic erosion. The vegetative cover consists of pinyon and juniper trees and associated shrubs and grasses. A profile of Stecum sandy loam on a 30 percent slope at an elevation of 9,680 feet is described as follows:

A_{11} 0 to 2½ inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) sandy loam; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous, pH approximately 6.8; approximately 15 percent of this horizon is gravel; lower boundary clear and smooth.

A_{12} 2½ to 5 inches, brown (10YR 5/3, dry) to dark-brown (10YR 3/3, moist) gravelly sandy loam; moderate, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; pH approximately 6.8; a few thin, indistinct clayskins on surfaces of some of the aggregates; approximately 30 percent of this horizon is gravel; lower boundary gradual and smooth.

C_1 5 to 8 inches, brown or yellowish-brown (10YR 5/3.5, dry) to brown or dark yellowish-brown (10YR 4/3.5, moist) gravelly loamy sand; weak, coarse, granular structure; slightly hard when dry, friable when moist; noncalcareous, pH approximately 7.2; about

Figure 7.—**Profile of Stecum sandy loam; bedrock is unconsolidated, highly weathered granite.**

75 percent of this horizon is gravel; lower boundary gradual and smooth.

C_2 8 to 17 inches +, yellowish-brown (10YR 5/4, dry) to dark yellowish-brown (10YR 4/4, moist) gravelly sand; massive; slightly hard when dry, friable when moist; noncalcareous, pH approximately 7.4; about 90 percent of this horizon is rock and gravel fragments.

These A-C soils owe their distinguishing characteristics largely to relief and its influence on the time factor. Their youthfulness is also due, in part, to the character of the parent materials, which are coarse and unstable. Geologic erosion is active because of the steep relief, sparse vegetation, and unstable soil materials. As a result of these conditions, the soil materials do not remain in place long enough to acquire, to any great degree, those characteristics that are a full reflection of climate and vegetation.

Scattered throughout areas of the Stecum soils are spots of Lithosols.

Laboratory Data

Physical and chemical characteristics of the soils, as determined by laboratory analyses, are given in tables 6 and 7.

The Chubbs, Nathrop, and Laporte soils, which are developing from limestone, are high in clay. The Bassel, Buena Vista, Edloe, and Stecum soils are comparatively low in clay. The low clay content of the Stecum and Edloe soils is closely related to the composition of the granite from which they are derived. The granite is high in quartz and orthoclase, both of which are very resistant to weathering. The Heath and Trout Creek soils, which are derived from shale, are high in silt. Large amounts of rock material are noted in the descriptions of some of these soils and should not be overlooked when performance interpretations are made.

The surface of all these soils is well supplied with organic matter; the surface layer of most of them is between 3 and 8 percent organic matter. The Bassel soils have the lowest organic-matter content—1.58 percent. The soils derived from limestone and shale are particularly high in organic matter. The Edloe soils are high in organic matter, but it is largely concentrated in the uppermost 2 inches. The Edloe soils, having a wide carbon-nitrogen ratio, are likely to be deficient in nitrogen for plant growth. The increase in organic carbon at depths well below the A horizon in a number of the soils suggests the possibility of buried soils. In the case of the Chubbs and Laporte soils, the increase may be due to root buildup above the limestone bedrock. Soils in mountainous areas are subject to soil creep and deposition of local colluvium and alluvium, so it is possible that the presence of organic carbon in the lower part of the profile is due to successive deposition and soil development.

In this area, soils derived from limestone and shale, such as the Chubbs, Nathrop, Laporte, Heath, and Trout Creek soils, have a comparatively high base-exchange capacity that is probably associated with their high clay content. The Stecum and Edloe soils have a much lower base-exchange capacity than the soils derived from shale or limestone and are also coarser textured. The Bassel soils have an A horizon that is comparatively low in both clay and organic matter and, consequently, has a lower base-exchange capacity. All of the soils have a high base-saturation percentage.

As indicated by moisture tension measurements, the Bassel, Buena Vista, and Stecum soils are expected to be somewhat droughty and the Edloe soils slightly less so. The finer textured soils derived from shale and limestone are capable of holding more available capillary water. Following extended droughts, however, light rains will be more beneficial to plants on the coarser textured Bassel, Buena Vista, and Stecum soils than on the finer textured Chubbs, Nathrop, Laporte, Heath, and Trout Creek soils. The finer textured soils retain more water in the hygroscopic form that is not available to plants.

TABLE 6.—*Particle size*

Soil and survey number	Horizon	Depth	Particle size distribution			
			Coarse fragments (>2 mm.)	Particles 2 mm. or less in size		
				Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*
Bassel sandy loam	A_1	0 to 3	14.4	22.1	15.5	7.9
S57 Colo–8–12(1–6)	A_3	3 to 6	12.2	13.6	13.7	10.9
	B_2	6 to 14	11.2	16.0	14.9	12.0
	B_{3ca}	14 to 21	21.9	18.5	16.2	10.6
	C_{ca}	21 to 32	36.3	28.8	17.5	7.4
	C	32 to 46+	24.9	29.9	25.8	9.7
Buena Vista very stony sandy loam	A_1	0 to 3	7.2	22.6	18.5	9.0
S57 Colo–8–10(1–5)	A_3	3 to 10	18.8	20.5	15.4	8.0
	B_2	10 to 16	26.9	20.0	16.7	7.5
	B_{3ca}	16 to 20	22.1	18.1	17.9	7.2
	C_{ca}	20 to 35+	34.6	8.5	16.3	10.1
Chubbs clay loam	A_1	0 to 2	[1]	[2,3] 1.8	[2,3] 1.5	[2,3] 1.0
S57 Colo–8–8(1–4)	B_2	2½ to 6	10.1	[2,3] 1.1	[2,3] 1.1	[2,3] .6
	B_3	6 to 11	35.2	[2,4] 5.2	[2,4] 2.5	[2,4] 1.2
	C_{ca}	11 to 19	35.4	[2,4] 4.2	[2,4] 4.8	[2,4] 3.0
Edloe gravelly sandy loam	A_1	0 to 2	47.3	22.2	15.5	6.0
S57 Colo–8–2(1–5)	A_2	2 to 8	49.3	25.9	20.4	8.8
	B_1	8 to 13	47.4	30.1	24.5	9.7
	B_2	13 to 18	54.3	27.8	23.7	9.4
	C_r	18 to 34+	57.6	15.0	28.7	13.0
Heath clay loam	A_1	0 to 2	19.2	[6] 8.6	[6] 6.1	[6] 3.3
S57 Colo–8–2(1–6)	A_3	2 to 5	3.0	[6] 4.6	[6] 4.6	[6] 2.8
	B_2	5 to 9	7.3	[7] 2.6	[7] 3.9	[7] 2.9
	B_{3ca}	9 to 13	23.7	[7] 6.5	[7] 5.0	[7] 3.0
	C_{ca}	13 to 28	35.0	[3,7] 10.4	[3,7] 6.5	[3,7] 3.3
	C	28 to 39	50.4	[3,7] 9.7	[3,7] 7.4	[3,7] 3.4
Laporte sandy loam	A_{11}	0 to 3	31.2	[8,9] 7.8	[8,9] 7.4	[8,9] 7.2
S57 Colo–8–9(1–4)	A_{12}	3 to 7	28.2	[8,9] 7.5	[8,9] 6.5	[8,9] 5.9
	AC	7 to 12	27.1	[8,9] 4.9	[8,9] 5.4	[8,9] 5.2
	C_{ca}	12 to 21	35.0	[3] 5.6	[3] 6.2	[3] 5.3
Nathrop loam	A_1	0 to 4	11.8	[9] 4.2	[9] 2.9	[9] 1.9
S57 Colo–8–5(1–4)	B_2	4 to 9	15.5	[9] 3.6	[9] 3.1	[9] 2.1
	B_{3ca}	9 to 13	25.8	[3] 3.8	[3] 3.9	[3] 2.6
	C_{ca}	13 to 19	30.5	[3] 4.6	[3] 4.9	[3] 3.3
Stecum gravelly sandy loam	A_1	0 to 2½	26.6	29.0	24.4	8.0
S57 Colo–8–6(1–4)	A_3	2½ to 5	39.0	25.1	20.4	7.0
	C_1	5 to 8	54.5	18.5	22.8	9.5
	C_2	8 to 17+	67.6	24.7	29.9	10.1
Trout Creek loam	A_1	0 to 3	6.1	[10] 4.6	[10] 4.3	[10] 2.9
S57 Colo–8–11(1–4)	A_3	3 to 6	11.0	[10] 2.1	[10] 2.2	[10] 1.5
	B_2	6 to 12	10.2	[10] 1.7	[10] 2.5	[10] 1.8
	B_3	12 to 20	4.0	[10] .4	[10] .8	[10] .6

[1] Trace.
[2] Few, irregular, dark-brown to black concretions, probably containing iron and manganese.
[3] Common concretions of calcium carbonate.
[4] Many concretions of calcium carbonate.
[5] Common flakes of mica.
[6] Few, smooth, light-brown to black concretions, probably containing iron and manganese.

distribution and moisture tensions

Particle size distribution—Continued						Moisture tension at—		
Particles 2 mm. or less in size—Continued				I.S.S.S.				
Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (<0.002 mm.)	Fine sand (0.2–0.02 mm.)	Silt (0.02–0.002 mm.)	1/10 atmosphere	1/3 atmosphere	15 atmospheres
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
13.7	11.6	20.9	8.3	30.8	8.6	20.9	9.8	3.9
18.7	11.0	16.1	16.0	28.6	7.4	18.1	11.1	6.2
16.6	10.7	12.8	17.0	27.0	5.5	18.8	12.8	7.4
16.5	11.5	12.5	14.2	27.7	5.5	14.7	10.6	6.0
9.1	4.4	11.8	21.0	12.7	8.0	24.8	18.6	9.1
8.9	3.2	9.7	12.8	9.8	7.1	16.5	11.8	6.3
11.7	9.2	20.0	9.0	26.9	8.7	25.3	16.2	6.6
10.6	8.7	22.2	14.6	26.7	10.2	30.3	18.2	9.3
9.5	9.3	21.5	15.5	25.7	10.6	28.1	18.8	8.5
11.0	9.0	24.1	12.7	26.0	12.9	25.6	19.4	8.0
15.8	10.6	24.3	14.4	28.4	14.3	35.3	27.3	11.9
[2][3] 4.8	[2][3] 14.2	52.3	24.4	43.3	26.6	53.1	38.9	17.2
[2][3] 2.8	[2][3] 11.0	44.0	39.4	33.2	23.9	32.1	27.1	13.9
[2][4] 4.4	[2][4] 14.4	42.2	30.1	36.7	23.0	31.8	25.3	11.6
[2][4] 6.5	[2][4] 11.0	40.8	29.7	29.0	26.9	62.4	46.7	21.8
[5] 5.2	[5] 10.1	32.5	8.5	28.5	14.9	30.3	18.9	6.1
[5] 11.3	[5] 7.7	20.6	5.3	25.0	8.6	19.0	10.6	3.8
[5] 11.9	[5] 5.7	12.4	5.7	17.9	5.7	10.3	7.6	2.8
[5] 10.6	[5] 7.7	14.2	6.6	19.3	6.6	12.7	8.3	3.0
[5] 20.8	[5] 7.6	8.6	6.3	21.8	4.6	11.1	7.3	2.4
[6] 6.2	[6] 8.0	40.8	27.0	28.7	23.5	41.2	28.3	12.9
[6] 6.0	[6] 7.3	35.8	38.9	25.3	21.1	40.4	26.1	14.5
[7] 5.4	[7] 6.4	34.5	44.3	22.0	22.2	38.8	27.9	16.4
[7] 4.2	[7] 4.9	35.2	41.2	16.8	25.9	38.7	28.5	17.4
[3][7] 4.5	[3][7] 5.2	36.7	33.4	16.4	28.2	30.8	23.7	12.9
[3][7] 4.3	[3][7] 4.0	40.7	30.5	13.9	33.2	29.1	22.0	11.4
[8][9] 12.2	[8][9] 12.1	33.5	19.8	34.6	18.4	36.8	24.3	11.7
[8][9] 10.7	[8][9] 11.6	36.1	21.7	33.7	20.6	40.8	28.6	13.6
[8][9] 10.8	[8][9] 13.8	36.0	23.9	37.2	19.5	51.1	34.3	18.4
[3] 12.7	[3] 17.9	31.6	20.7	42.3	15.4	57.8	39.0	22.3
[9] 3.8	[9] 7.9	47.6	31.7	27.6	30.5	45.5	31.4	14.9
[9] 4.3	[9] 7.5	41.8	37.6	23.8	28.4	33.0	25.8	14.1
[3] 5.5	[3] 8.9	39.4	35.9	26.0	25.9	34.0	27.1	14.7
[3] 7.3	[3] 11.2	36.5	32.2	29.5	23.0	37.5	28.8	14.9
9.4	5.0	17.3	6.9	17.0	9.5	23.4	13.1	5.0
[5] 9.5	[5] 4.8	22.9	10.3	19.8	12.5	23.3	12.7	4.5
[5] 14.4	[5] 6.3	16.7	11.8	21.1	8.9	15.2	10.4	5.2
[5] 15.0	[5] 5.1	7.6	7.6	15.2	4.7	13.2	8.4	5.0
[10] 6.2	[10] 6.2	46.2	29.6	23.9	31.8	37.7	29.7	13.4
[10] 3.7	[10] 5.5	53.0	32.0	23.6	37.0	36.3	29.7	12.8
[10] 3.7	[10] 4.9	50.1	35.3	20.3	36.7	30.1	26.0	12.7
[10] 1.4	[10] 1.5	27.4	67.9	5.8	23.9	36.1	29.6	19.3

[7] Common, smooth, light-brown to black concretions, probably containing iron and manganese.

[8] Few, irregular, light-brown to black concretions, probably containing iron and manganese.

[9] Few concretions of calcium carbonate.

[10] Common, irregular, brown concretions, probably containing iron, and few, smooth, black concretions, probably containing manganese.

TABLE 7.—*Chemical*

Soil and survey number	Horizon	Depth	pH at 1:1 ratio	Free iron (Fe_2O_3)	$CaCO_3$ equivalent
		In.		*Pct.*	
Bassel sandy loam	A_1	0 to 3	5.9	1.5	
S57 Colo-8-12(1-6)	A_3	3 to 6	6.9	1.9	<1
	B_2	6 to 14	7.4	1.9	<1
	B_{3ca}	14 to 21	8.2	1.8	2
	C_{ca}	21 to 32	8.5	.8	12
	C	32 to 46+	8.3	1.5	3
Buena Vista very stony sandy loam	A_1	0 to 3	6.1	1.1	
S57 Colo-8-10(1-5)	A_3	3 to 10	6.4	1.2	
	B_2	10 to 16	7.5	1.1	<1
	B_{3ca}	16 to 20	8.2	1.0	2
	C_{ca}	20 to 35+	8.3	1.2	2
Chubbs clay loam	A_1	0 to 2½	6.7	1.9	<1
S57 Colo-8-8(1-4)	B_2	2½ to 6	7.3	2.6	2
	B_3	6 to 11	7.7	2.2	13
	C_{ca}	11 to 19	7.7	1.2	52
Edloe gravelly sandy loam	A_1	0 to 2	6.5	.9	<1
S57 Colo-8-2(1-5)	A_2	2 to 8	5.9	.9	
	B_1	8 to 13	6.2	.8	
	B_2	13 to 18	6.4	.9	
	C_r	18 to 34+	6.7	.6	<1
Heath clay loam	A_1	0 to 2	7.4	2.9	<1
S57 Colo-8-2(1-6)	A_3	2 to 5	7.5	3.2	<1
	B_2	5 to 9	7.7	3.3	2
	B_{3ca}	9 to 13	7.9	2.7	14
	C_{ca}	13 to 28	8.1	2.5	28
	C	28 to 39	8.2	2.6	20
Laporte sandy loam	A_{11}	0 to 3	7.9	.8	26
S57 Colo-8-9(1-4)	A_{12}	3 to 7	7.9	.8	20
	AC	7 to 12	7.9	.7	33
	C_{ca}	12 to 21	7.9	.5	47
Nathrop loam	A_1	0 to 4	7.8	2.9	9
S57 Colo-8-5(1-4)	B_2	4 to 9	7.9	3.1	9
	B_{3ca}	9 to 13	8.0	2.8	17
	C_{ca}	13 to 19	8.0	2.2	33
Stecum gravelly sandy loam	A_1	0 to 2½	7.0	1.4	<1
S57 Colo-8-6(1-4)	A_3	2½ to 5	7.1	1.7	<1
	C_1	5 to 8	7.3	1.9	<1
	C_2	8 to 17+	7.4	1.5	<1
Trout Creek loam	A_1	0 to 3	7.2	4.4	<1
S57 Colo-8-11(1-4)	A_3	3 to 6	7.4	4.5	<1
	B_2	6 to 12	7.4	4.7	<1
	B_3	12 to 20	7.2	4.4	<1

characteristics of the soils

Organic matter		Cation exchange capacity (NH_4Ac)	Extractable cations					Base saturation on sum + H
Organic carbon	Nitrogen		Ca	Mg	H	Na	K	
Pct.	*Pct.*	*Meq. per 100 g. soil*	*Meq. per 100 g. soil*	*Meq. per 100 g. soil*	*Meq. per 100 g. soil*	*Meq. per 100 g. soil*	*Meq. per 100 g. soil*	*Pct.*
0. 92	0. 090	8. 0	4. 8	1. 2	4. 0	<0. 1	0. 5	62
. 89	. 070	13. 6	10. 7	3. 0	2. 0	<. 1	. 6	88
. 54	. 047	15. 9	12. 8	3. 8	1. 6	<. 1	. 6	91
. 26	. 020	13. 6	16. 4	4. 1	. 8	. 1	. 6	96
. 32	. 026	16. 5	27. 8	5. 2	<. 1	. 6	. 6	100
. 05		11. 9	26. 6	5. 9	<. 1	. 9	. 4	100
1. 83	. 124	10. 2	5. 8	1. 4	4. 0	<. 1	1. 1	67
1. 71	. 160	14. 0	9. 4	2. 1	3. 2	<. 1	1. 5	80
. 87	. 072	15. 4	11. 8	2. 8	1. 6	. 2	2. 5	92
. 39	. 043	14. 7	22. 2	2. 9	<. 1	. 6	3. 4	100
. 12	. 009	22. 2	28. 1	4. 1	<. 1	1. 5	5. 0	100
9. 12	. 460	35. 9	34. 8	2. 7	8. 6	<. 1	1. 6	82
1. 65	. 097	25. 8	30. 6	1. 8	3. 3	<. 1	1. 1	91
1. 74	. 117	23. 2	36. 3	1. 7	. 4	<. 1	. 5	99
5. 46	. 259	25. 4	42. 8	1. 5	<. 1	<. 1	. 2	100
4. 47	. 183	18. 2	15. 0	1. 4	8. 3	<. 1	. 8	67
1. 25	. 045	8. 2	5. 6	. 6	4. 1	<. 1	. 4	62
. 44	. 022	5. 4	4. 0	. 6	2. 7	<. 1	. 4	63
. 37	. 016	5. 4	3. 9	. 6	1. 8	<. 1	. 4	73
. 17	. 007	4. 1	2. 9	. 4	1. 4	<. 1	. 3	72
3. 24	. 294	26. 2	24. 8	3. 1	2. 0	<. 1	2. 4	94
3. 09	. 266	30. 0	28. 2	3. 3	2. 4	<. 1	1. 8	93
3. 09	. 287	30. 2	34. 0	3. 7	1. 2	<. 1	1. 2	97
2. 47	. 237	21. 9	31. 5	3. 4	<. 1	<. 1	. 6	100
. 99	. 123	15. 0	25. 1	5. 0	<. 1	. 1	. 3	100
. 74		14. 8	21. 4	7. 3	<. 1	. 1	. 3	100
3. 32	. 207	20. 6	32. 6	3. 7	<. 1	<. 1	1. 0	100
3. 50	. 213	23. 8	35. 3	5. 5	<. 1	<. 1	. 6	100
3. 72	. 222	22. 8	37. 6	7. 4	<. 1	<. 1	. 4	100
4. 34	. 218	22. 6	32. 8	9. 7	<. 1	<. 1	. 2	100
4. 91	. 289	30. 0	42. 5	3. 1	1. 2	<. 1	2. 1	98
2. 02	. 147	29. 0	45. 6	2. 6	<. 1	<. 1	. 7	100
1. 70	. 125	25. 6	41. 8	2. 4	<. 1	<. 1	. 4	100
1. 56	. 122	19. 8	38. 8	2. 3	<. 1	<. 1	. 3	100
3. 70	. 181	11. 8	9. 6	1. 6	3. 6	<. 1	. 6	77
1. 15	. 076	11. 0	8. 6	1. 6	2. 3	<. 1	. 6	82
. 84	. 035	11. 3	9. 6	2. 1	2. 3	<. 1	. 4	84
. 34	. 011	11. 0	11. 4	2. 4	1. 8	<. 1	. 3	89
4. 57	. 276	29. 2	25. 8	4. 0	4. 1	<. 1	2. 4	89
2. 76	. 183	28. 0	26. 4	4. 3	3. 7	<. 1	. 7	89
1. 38	. 116	25. 3	21. 6	4. 3	4. 5	. 1	. 5	85
1. 28	. 110	36. 4	30. 6	6. 2	4. 6	. 1	. 6	89

Part III: Soil Use and Management

Most of the problems of soil management in Trout Creek Watershed are the result of past abuses and present competing demands. Beginning in 1860, much of the area was seriously depleted of its vegetative cover. At present, 16.9 percent of the watershed is affected to a moderate degree by erosion, and 22.8 percent is severely eroded. Deer and domestic animals compete for the available forage, resulting in further damage to the protective plant cover.

Rehabilitating the watershed, a program now under way, will require practices to reduce runoff, prevent flash floods, maintain stream flow, and halt erosion. Restoring the plant cover is of prime importance. Only through a coordinated program of planting, grazing control, and fire prevention can an adequate cover of desirable plants be established and maintained. Control of grazing and a temporary reduction of the wildlife population will give range and browse plants a chance to recover and will, in the long run, improve the wildlife habitats, the range, and the timber lands and will help to control erosion and increase sustained water yields. Improving camp and picnic grounds and increasing patrol activity will help prevent damaging fires. If timber is removed it should be harvested by methods that will not create new erosion problems.

Other precautions against erosion would be to limit the number of roads and trails, to keep the necessary ones in good repair, to keep road gradients to a minimum, and to provide good drainage for roadways.

Rehabilitation practices that are tried and that prove successful here can be applied to many other areas along the Front Range of Colorado where the soils, topography, and climate are similar.

Major Uses

The Federally owned part of Trout Creek Watershed is under multiple-use management to increase the production of timber and forage, to protect wildlife, to develop recreational facilities, and to increase sustained yields of water. In general, the best uses for Stecum and Edloe soils appear to be sustained water yield, wildlife, and recreation. The best uses for the Chubbs, Nathrop, and Laporte soils are sustained water yield, timber, and herbage; for the Trout Creek, Garo, and Heath soils, sustained water yield and herbage; and for the Buena Vista soils, sustained water yield and the protection of wildlife. Table 8 shows the estimated relative suitability of the soils for herbage and timber and their relative capacity for sustained water yield.

About 11 percent of the watershed is State owned, and about 7 percent is privately owned. Some prospecting goes on, and there are a few mines.

Some of the most productive soils and some of the locations best suited to development as recreational areas are owned by the State or by private owners.

TABLE 8.—*Estimated relative suitability of the soils for herbage production, timber production, and sustained water yield*

[Ratings based primarily on field observations and experiences of soil scientists, forest rangers, and forest technicians. No research data were available. The ratings apply only to the soils mapped in this survey area.]

Soil or land type	Herbage production [1]	Timber production [2]	Water yield [3]
Alluvial land	Excellent	Good	High.
Bassel sandy loam	Good	Fair	High.
Bassel sandy loam, severely eroded	Very poor	Very poor	Medium.
Buena Vista very stony sandy loam	Fair	Poor	High.
Buena Vista very stony sandy loam, eroded	Fair	Poor	High.
Buena Vista very stony sandy loam, severely eroded	Very poor	Very poor	Medium.
Chubbs clay loam	Good	Fair	Medium.
Edloe gravelly sandy loam	Fair	Fair	Medium.
Garo clay loam	Fair	Poor	Low.
Garo clay loam, severely eroded	Poor	Very poor	Low.
Heath loam and clay loam	Good	Fair	Medium.
Heath clay loam, eroded	Good	Poor	Medium.
Laporte-Nathrop-Trump complex	Fair	Poor	Low.
Laporte-Nathrop-Trump complex, severely eroded	Poor	Very poor	Low.
Peat, muck, and alluvial land	Good	Very poor	High.
Stecum sandy loam, 0 to 8 percent slopes	Poor	Poor	Low.
Stecum sandy loam, 0 to 8 percent slopes, eroded	Poor	Very poor	Low.
Stecum sandy loam, 8 to 40 percent slopes	Poor	Poor	Low.
Stecum sandy loam, 8 to 40 percent slopes, eroded	Poor	Very poor	Low.
Stecum sandy loam, 8 to 40 percent slopes, severely eroded	Very poor	Very poor	Low.
Stony land, Buena Vista materials	Poor	Poor	Medium.
Stony land, Chubbs materials	Fair	Fair	Medium.
Trout Creek loam	Good	Fair	Medium.
Trout Creek clay loam, eroded	Good	Poor	Medium.
Wellsville very fine sandy loam	Good	Fair	High.
Miscellaneous land types [4]	Very poor	Very poor	Very low.

[1] Rated according to suitability for mountain bunchgrass; included are Arizona fescue, danthonia, Thurber's fescue, mountain muhly.

[2] Rated according to suitability for ponderosa pine. Other species are not present in large enough quantities to permit the development of a rating.

[3] Refers to the capacity of the soil and underlying materials to store water for slow release through springs and seeps to maintain stream flow. See Glossary.

[4] Includes Rock land and Rock outcrop.

Timber

Little commercial timber is now found in the watershed, but the forests are important in stabilizing the soils. Alluvial land, which is high in fertility and has adequate moisture-holding capacity, offers the best prospect for production of better quality timber. Even the best of the upland soils are only fair for timber. North-facing slopes are somewhat better than south-facing slopes, which supply less moisture. Severely eroded soils have no potential for commercial timber, and the rocky miscellaneous land types are very poor.

The trees that have some commercial value include ponderosa pine, Douglas-fir, lodgepole pine, blue spruce, and Engelmann spruce. Ponderosa pine is the most extensive and the most important commercially. Timber should be harvested only where doing so would not further deteriorate the soils. Scattered trees of commercial value on the poorer, unstable soils should not be cut if logging would involve risk of permanent damage to the watershed. Thinning should be restricted to areas where the soils are productive and the erosion hazard is slight. Cutting on steep, south-facing slopes is particularly hazardous. Logs cut for control of insects or diseases should not be salvaged by conventional methods; nor should logs be salvaged after fires, unless extraordinary precautions are taken. Slash should be lopped and scattered.

Pinyon, juniper, and quaking aspen grow only to scrub size and at present have no commercial value. Aspen forms a good protective cover for the soil; it also provides forage for big game and food for beaver. Consequently, some stands of aspen should be improved and perpetuated.

Reforestation with conifers is most likely to be successful on the Edloe soils. These soils are sufficiently deep over bedrock, and they are on northerly exposures where moisture conditions are favorable. Plantings on shallow soils on hot, southerly exposures—the Stecum soils, for example—are not likely to be successful. On most soils of this area, plantings within existing stands, where some protection from wind and sun are afforded, are more likely to succeed than those in open areas.

Shrubs

Sand cherry, chokecherry, caragana, Russian-olive, mountain-mahogany, and willow are the species of shrubs that appear to be best suited to this area. Planting shrubs in unstable drainageways is advisable if there are enough gully plugs or contour ditches to minimize or eliminate channel cutting and sloughing. Uncontrolled runoff in a gully will wash the soils away from the roots of shrubs or smother the plants in sediment. Planting in contour ditches, so as to utilize the trapped moisture, appears to be a good practice, provided the shrubs are protected from being covered with sediment. On unstable soils, it may be advisable to make the ditch or contour furrow one year and plant shrubs the following year. This will help to prevent sedimentation, because the disturbed soil has a year to settle and stabilize. Willow plantings have a better chance of being successful if made on the side of the gully channel that is shaded during the hottest part of the day.

Shrubs provide food and cover for wildlife and form a good ground cover. They may also improve the porosity and structure of the soil and, to some extent, increase the fertility and add to the humus content.

Herbage

The soils best suited to the production of herbage are the alluvial soils and the deeper, more fertile soils of the uplands, which are relatively high in fertility and water-supplying capacity. The soils that were derived from granite are shallow, droughty, and lacking in fertility, and consequently they are only fair to poor for herbage. Severely eroded soils are also poor, because they are droughty and low in fertility.

Most of the range herbage in Trout Creek Watershed falls in one of three types: mountain bunchgrass, pinyon-juniper, and coniferous forest. The types differ significantly in climate, topography, and soil requirements.

The most extensive of the three is the mountain bunchgrass type, which grows on valley alluvium at the lower elevations where the annual precipitation is low. Fescues, muhly, western wheatgrass, needle-and-thread, blue grama, Indian ricegrass, and palatable weeds provide most of the herbage crop. This is primarily summer range for cattle. Most of it is in poor condition; the grazing capacity now is about 10 to 15 acres per animal-unit-month. To assure sustained production, the range should be stocked conservatively.

The pinyon-juniper type of range herbage grows where the soils are shallow and stony and the topography is rough. It occurs at a little lower elevation than the mountain bunchgrass type. In some places the two types are mixed, with the mountain bunchgrass type occupying the better soils. Most of the range in the pinyon-juniper zone receives less than 12 inches of rainfall annually. Its productive capacity is low, and artificial seeding is impractical because of steep slopes, poor soils, and insufficient moisture. Most of this range is in very poor condition. The understory is sparse and consists mostly of muhly, Indian ricegrass, squirreltail, blue grama, sagebrush, and mountain-mahogany. Deer graze this range heavily in winter.

The range in the coniferous forest consists of grassy areas interspersed with stands of timber. It is predominantly summer range. Most of it is at high altitudes where snow comes early and stays late. The grazing capacity varies considerably. The capacity of areas in poor to fair condition is about 8 to 15 acres per animal-unit-month in summer. If in good condition, the areas that receive the most precipitation have a higher potential capacity.

To improve the range and provide erosion protection on the watershed, about 950 acres have been seeded to crested wheatgrass, and several miles of fence have been installed. Contour ditches and terraces have been built to hold moisture and control gullying. Water-spreading structures have been built to some extent.

Water

Water is an important product of Trout Creek Watershed, and improving streamflow and increasing the yield of usable water are the major advantages of management. According to their potential for sustained water yield, the soils are rated high, medium, low, or very low (see table 8). Sustained water yield, as used here, refers to the capacity of the soil and the underlying unconsolidated material to absorb and store water for slow release to

Figure 8.—**Shale and interbedded shale and sandstone deflect percolating water, so that little water is stored for slow release to springs and streams.**

springs and streams. Storage capacity depends mainly on the permeability of the surface soil and the depth to bedrock. If the bedrock is highly fractured or only weakly consolidated, it also will store some water. Shale bedrock, because of its platy structure, tends to deflect water toward the surface (fig. 8). Seeps and springs that appear on the lower parts of slopes after rains are evidence of this.

The rate of runoff and the characteristics of the rainfall also have an effect on water yield. Runoff after rains of high intensity and short duration is rapid, primarily because of the steep slopes, the poor vegetative cover, and the poor condition of the soils.

The alluvial soils, because they are deep to bedrock, rate high in water production. The soils that were derived from granite are shallow, and therefore have little capacity for storing water. They are also steep, so runoff is rapid to excessive. The Stecum and Edloe soils are examples. The soils that were derived from trachyte, such as the Buena Vista, are sandy and porous, so infiltration of water is rapid; and the loose bedrock is capable of storing considerable amounts of water.

Subsurface flow can be evaluated by the number of springs in an area. Most of the springs are at the base of mesas capped by trachyte. The biggest continuously flowing spring in the watershed is along a rock fault line at the lower end of Chubbs Park.

Two water-gaging stations have been established in the headwaters of Castlerock Gulch to obtain data that will make it possible to compare water yields from an eroded watershed and from one that is relatively uneroded. Most of the soils in both watersheds belong to the Stecum and Edloe series.

Hydrologic soil groups.—Information about runoff potential is essential to watershed planning, since runoff potential determines, to a large extent, the flood hazard, the character and amount of flow of streams and springs, and the hazard of erosion resulting from rainwater or snowmelt.

In the engineering handbook for hydrology [4] developed by hydrologists of the Soil Conservation Service, the Forest Service, and other agencies, the major soils of the United States have been placed in four hydrologic groups.

These groups are based on intake of water at the end of long-duration storms, after prior wetting and opportunity for swelling, without consideration to slope or the protective effects of vegetation. They indicate runoff potential and should not be confused with ratings for water yield, which indicate storage capacity.

There are four hydrologic groups [4]:

Group A consists of soils that have a high infiltration rate, even when thoroughly wetted, chiefly deep, well-drained to excessively drained sand, gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted and that are chiefly moderately deep to deep, moderately well drained to well drained, and moderately fine textured to moderately coarse textured. These soils have a moderate rate of water transmission.

Group C consists of soils that have a slow rate of infiltration when thoroughly wetted, chiefly soils that have a layer that impedes downward movement of water and soils that are moderately fine textured to fine textured. These soils have a slow rate of transmission.

Group D consists of soils that have a very slow rate of infiltration when thoroughly wetted, chiefly clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

Table 9 shows the hydrologic group for each of the soils in Trout Creek Watershed, according to the above classification.

In using the hydrologic grouping to estimate runoff, it is necessary to take into account precipitation, slope, effect of vegetative cover, and other factors. If an estimate of runoff is needed for use in planning for a particular watershed, a hydrologist should be consulted.

Wildlife

The best forest environment for wildlife is a mixture of food-bearing and cover-producing plants (trees, shrubs, and herbs), plus water and escape areas, all within the daily travel range of the species (*12*). The destruction, by fire or overuse, of the plants that provide food and cover can cause a reduction in the number of big game animals, birds, and fish.

The best wildlife winter habitat areas in the watershed are in the Stecum-Edloe soil management area (see figure 9). The lower part of this area is particularly good winter range for mule deer. It has many southerly exposures, it provides food and water, and it has many rock outcrops

[4] Engineering Handbook, Hydrology, Supplement A, Sec. 4, Soil Conservation Service, USDA.

TABLE 9.—*The soils and their hydrologic groups, erodibility classification, and erosion hazard*

[Evaluations are based primarily on field observations and experiences of soil scientists, forest rangers, and forest technicians. No research data were available. Evaluations apply only to the soils mapped in this survey area]

Soil or land type	Hydrologic soil group [1]	Erodibility classification [2]	Erosion hazard [3]
Alluvial land	A	I	Slight.
Bassel sandy loam	B	II	Moderate.
Bassel sandy loam, severely eroded.	C	III	High.
Buena Vista very stony sandy loam.	B	II	Moderate.
Buena Vista very stony sandy loam, eroded.	B	III	High.
Buena Vista very stony sandy loam, severely eroded.	C	III	High.
Chubbs clay loam	C	III	Moderate.
Edloe gravelly sandy loam	B	III	High.
Garo clay loam	C	IV	High.
Garo clay loam, severely eroded.	D	V	High.
Heath loam and clay loam	C	III	High.
Heath clay loam, eroded	D	IV	High.
Laporte-Nathrop-Trump complex.	C	IV	High.
Laporte-Nathrop-Trump complex, severely eroded.	D	V	High.
Peat, muck, and alluvial land	D	I	None to slight.
Stecum sandy loam, 0 to 8 percent slopes.	C	IV	High.
Stecum sandy loam, 0 to 8 percent slopes eroded.	C	IV	High.
Stecum sandy loam, 8 to 40 percent slopes.	D	IV	High.
Stecum sandy loam, 8 to 40 percent slopes, eroded.	D	IV	High.
Stecum sandy loam, 8 to 40 percent slopes, severely eroded.	D	V	High.
Stony land, Buena Vista materials.	C	II	High.
Stony land, Chubbs materials	D	II	Moderate.
Trout Creek loam	C	IV	High.
Trout Creek clay loam, eroded	D	V	High.
Wellsville very fine sandy loam	B	III	Moderate.
Miscellaneous land types [4]	D	V	Moderate.

[1] Hydrologic soil grouping according to Engineering Handbook, Hydrology, Sup. A, Sec. 4, Soil Conservation Service, USDA. Refers to runoff potential.

[2] Refers to stability or instability of soils when subjected to surface erosion by water; classification is determined by profile characteristics of the soil and does not take into consideration climate, vegetation, man's activities, and such factors of environment. The most stable soils are in class I, and the least stable are in class V.

[3] Refers to susceptibility to accelerated erosion when soil or vegetation is disturbed by fires or activity of man.

[4] Includes Rock land and Rock outcrop.

and rough terrain for concealment and escape. The area generally has less than 12 inches of loose snow in winter.

The limited size of this winter range area may limit the deer population.

The greater proportion of the Chubbs-Nathrop-Trump soil management area is poor winter range because of deep snow. In general, the Garo-Heath-Trout Creek soil management area has neither large outcrops nor rugged terrain to provide concealment and escape routes. Northerly exposures dominate the landscape of the Buena Vista-Rock land area and, since mule deer favor sunny exposures in winter, this area is poor winter range.

Revegetating with woody and shrubby plants and any other practices that help to restore the native plant cover will improve the winter wildlife habitat. Shrubs furnish much of the winter diet for deer—75 percent or more in many places. Reducing the deer population, where necessary, would give the native browse plants a chance to recover.

Beaver have been trapped and removed from the streams because the food supply (willow and aspen) was inadequate to support them. They should be kept out until the food supply has improved. The grade and the width of the stream valley and the nature of the bedrock are important in determining whether an area is suitable for beaver (*7*). They should be permanently excluded if the valley is steep or narrow or if the bedrock is highly erosive and there is unusual risk of dam breakage.

There are practically no fish in the watershed at present because most of the streams are intermittent. The streams could be improved as habitats for fish by planting aspen and willow along the banks and by reducing erosion in the uplands and along the channel banks. Installing dams to create ponds and raise the general level of the water table in stream valleys helps to maintain streamflow.

Recreation

Some of the important factors to be considered in planning recreational facilities are aspect, topography, soil fertility, soil texture, permeability, depth, drainage, and moisture relationships. The physical characteristics of the soils affect erodibility, trafficability, the tendency to compaction, and the windthrow hazard.

Picnic and camp grounds are best located on nearly level areas. The soils should be well drained and safe from flooding. Loam, silt loam, and light sandy clay loam textures are preferable. Finer textured soils become hard, and the loose sandy soils will not support a cover of grass if intensively used. Many good picnic and camp grounds are on the deep, fertile, friable, well-drained alluvial soils on the bottom lands. These soils are nearly level sandy loams or loams. If recreational areas are located on soils that are extremely coarse textured or extremely fine textured, or are shallow, steep, or eroded, or have a high water table, there will be special problems of design and management.

Because they are used intensively, some recreational areas may require intensive management, including fertilization, mulching, landscaping, and stabilization or surfacing of roads and walks. A permanent type of soil stabilizer may be needed for soils that tend to be erosive. Soil-cement, a mixture of pulverized soil, portland cement, and water, compacted to high density (*6*), may be suitable for stabilizing walks, picnic table areas, and areas subject to heavy use. Mulches of various types can be used to stabilize newly seeded areas and steep road cuts. Straw, sawdust, and leaves are the materials most commonly used, but asphalt mulches can also be used effectively.[5] Grass, shrubs, and trees can be fertilized by broadcast,

[5] Smith, Harold M. The effect of asphalt mulches on the stabilization of soils and aggregate materials and on vegetational cover. Abstract of thesis, Univ. of Ill., 1953.

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placement, foliage application, and various other methods. The need for fertilizer will depend on the kind of soil.

The area occupied by the Stecum and Edloe soils and Rock outcrop (soil management area 1, see fig. 9) offer the best opportunities for recreational development. This part of the watershed provides considerable big-game hunting and is scenically attractive. It is readily accessible by way of U. S. Highway No. 24-285. Along the highway there are areas suitable for camp and picnic grounds, and parts of Chubbs Park, which is near the headwaters of Trout Creek, are suitable for picnic grounds. Other isolated areas, as yet undeveloped, have physical possibilities for recreational purposes.

Deer hunting is one of the chief recreational uses. The best place for this is the lower part of the Stecum-Edloe soil management area, which is a key winter range area for mule deer.

Erodibility and Inherent Erosion Hazard

Erodibility and the hazard of erosion affect the use and management of soils. Table 9 gives an erodibility classification and an estimate of the inherent erosion hazard for each of the soils in the watershed. The erodibility classification attempts to show the relative resistance of the soils to surface erosion by water, without regard to such other environmental factors as climate, slope, and vegetation. The inherent erosion hazard is an attempt to evaluate the susceptibility of the soil to accelerated erosion resulting from the disturbance or destruction of the vegetation or from other human activities.

Erodibility depends largely upon two qualities of the soil: the stability of the aggregates in the surface layer, and the ease with which the soil becomes saturated. Stability of the aggregates refers to their resistance to dispersion when wetted. In some soils, the aggregates are stable and are not easily dispersed or transported by water; in others, the aggregates are easily broken down into smaller units or individual grains of sand and silt and are easily carried away by surface runoff. Soil stability, or lack of it, can be referred to as "ease of detachability" of the aggregates.

The ease with which a soil becomes saturated depends in part upon its capacity to hold water. This can be called its "saturation potential." After a soil is saturated, any additional rainwater runs off the surface and may cause erosion. Soil characteristics that reduce the rate of infiltration, restrict permeability, or reduce the water-holding capacity will increase surface runoff. The amount of soil carried away by runoff depends largely on the stability and size of the aggregates. Gravel and stones increase stability, but they are transportable if the runoff is of sufficient volume and velocity.

To calculate the erodibility classification of the soils, the following system was used:

The surface soils were assigned values based on the size of the soil aggregates and their resistance to dispersion after wetting. These values, called "detachability indexes," ranged from 1 to 10. A value of 1 or 2 was assigned if the aggregates were strongly resistant to dispersion and if most of them were more than 10 millimeters in size. A value of 9 or 10 was assigned if the aggregates were very weakly resistant to dispersion and if most of them were less than 10 millimeters in size. Intermediate values were assigned if the aggregates were between these two extremes.

Values of 1 to 10, based on capacity to dispose of infiltrated water, were then assigned to the soils; these values are called "saturation potential indexes." A value of 1 or 2 indicates that the soil is capable of disposing of large amounts of infiltrated water over long periods of time, with little surface runoff. Soils that have values of 1 or 2 are generally deep, coarse textured, and rapidly permeable. Soils that have values of 9 or 10 generally have bedrock, claypan, or other restricting layer very close to the surface. Intermediate values, depending upon texture and permeability, were assigned to soils between these two extremes.

An erodibility index is obtained by reducing the estimated detachability index by the percentage of coarse fragments on the surface and multiplying the adjusted detachability index by the estimated saturation potential index. For example, a soil that would normally have a detachability index of 5 and a saturation potential of 8, but which has 20 percent of coarse fragments on the surface, would have a soil erodibility index of 32. The detachability index is reduced as follows: 5 x .20=1; 5−1=4; or, considering that 80 percent of the surface is unprotected by coarse fragments, 5 x .80 = 4. This adjusted detachability index is multiplied by the saturation potential index of 8, giving a soil erodibility index of 32 (moderate). The erodibility index is then translated into the erodibility classification (see table 9) as follows:

	Classification
0 to 5 (very low)	I
6 to 20 (low)	II
21 to 40 (moderate)	III
41 to 70 (high)	IV
71 to 100 (very high)	V

The inherent erosion hazard (see table 9) depends partly on erodibility and partly on climate, slope, and many other environmental factors. It is an indication of the relative susceptibility of the soils to accelerated erosion if the vegetation is disturbed as a result of fire, clear cutting of timber, overgrazing, trampling by livestock, or other causes. The estimates of erosion hazard given in table 9 are based on conditions in Trout Creek Watershed and take into account the amount and intensity of rainfall in that area.

Engineering

The suitability of soil material for engineering structures, such as roads and water-retaining structures, can be rated in general terms only, since much depends upon the condition of the area, the size of the structure, the engineering methods used, and other factors. Individual ratings are given for hard-surfaced roads, unsurfaced roads, and water-retaining structures, since the material requirements are different. For example, soil material that consists almost entirely of sand would be poor for unsurfaced roads because it would lack stability under wheel loads, but it may be good to excellent for certain types of paved roads, particularly if confined, because it has no detrimental capillarity or elasticity. Such material would be unsuitable for water-retaining structures because it lacks a binder for stability and is too porous.

In assigning suitability ratings for engineering purposes, the soil profile and character of the bedrock were both considered. The characteristics of the various horizons were considered and weighed as to relative significance. For example, if the subsoil has very favorable properties but the surface soil and parent material have very unfavorable properties, then the soil would receive a low rating, particularly if the subsoil layer was very thin. If the soil is shallow, the parent material forms the bulk of the construction material. Although based only on field observation and general knowledge of soil behavior, the physical properties, such as cohesion, elasticity, compressibility, and capillarity, were considered in rating the soils. The ratings are given in table 10.

In general, the Edloe and Stecum soils, which are of granitic origin, are not good for water-retaining structures because they are too pervious and they lack sufficient clay for a binder. If properly compacted they are suitable base materials for surfaced roads, but considerable maintenance is required.

Soils and material derived from shale are generally poor for either roads or water-retaining structures. Shale material, owing principally to its high silt content, is unstable and therefore erosive. Shale bedrock under fill material deflects water so that seepage lines develop at the point of contact of the fill and the bedrock. Due to the instability of the material, the seepage lines develop into channels that weaken the structure. Detrimental capillarity in silty material causes heaving in freezing weather, and during subsequent thaws the soil loses stability as a result of the segregation of both ground and capillary water.

Soils high in organic matter, such as peat and muck, are very poor material for any kind of structure. Because of low internal friction, low cohesion, elasticity, and high capillarity, this material has a very low supporting value.

The value of alluvial material for either roads or water-retaining structures is highly variable and depends upon the source of the sediments. Sediments washed from areas of shale or limestone will be high in silt; those washed from areas of granite or trachyte are sandy and possibly gravelly.

Owing to the wide variation in soil material, the nature of the soil material and foundation should be investigated by borings and test pits at the site of proposed construction. If the soils are known to have unfavorable characteristics, engineers can use special construction methods that will reduce the chance of failure and the need for subsequent maintenance. The classification given in table 10 is an indication of general characteristics important in engineering. This method of classification does not eliminate possible overlapping and does not provide a rigid measure of soil behavior (*2*). This report gives only a general idea of the suitability of the soils for engineering uses, and points out some of the adverse characteristics of the various soil materials in the survey area.

Soil Management Areas

Soils occur in characteristic positions on the landscape and in characteristic geographic patterns. By grouping soils that normally are associated, we get a generalized map that is useful in planning the management of large areas. The generalized map of Trout Creek Watershed (fig. 9) shows four groups of soils, which in this report are called soil management areas. Any one of the areas may include soils that differ from each other in use suitability and management needs, but each area is dominated by a particular soil or combination of soils whose characteristics generally determine the management direction for the area as a whole.

The four soil management areas in Trout Creek Watershed are described in the following pages. In table 11, the major characteristics of each of the areas are summarized. More detailed information about the soils and land types in each area is given in the section, Descriptions of Mapping Units. These four generalized units are

TABLE 10.—*Suitability of soil material for roads and water-retaining structures*

[Ratings based on field observations of soil characteristics and behavior and on discussions with engineers and other Forest Service personnel]

Origin of soil material	Series or land type	Engineering classification (AASHO)	Suitability for use in—		
			Hard-surfaced roads	Unsurfaced roads	Water-retaining structures
Alluvium	Alluvial land	(1)	(1)	(1)	(1).
Alluvium	Bassel	A–2	Good	Fair	Poor.
Alluvium	Peat, muck, and alluvial land.	(2)	Very poor	Very poor	Very poor.
Colluvium and alluvium	Heath	A–4	Good	Fair	Fair.
Colluvium and alluvium	Wellsville	A–4	Good	Fair	Fair.
Granite	Edloe	A–2	Very good	Fair	Fair.
Granite	Stecum	A–3	Very good	Fair	Poor.
Limestone	Chubbs	A–4	Fair	Good	Good.
Limestone	Laporte	A–4	Fair	Fair	Poor.[3]
Limestone	Nathrop	A–4	Poor	Good	Poor.[3]
Limestone	Trump	A–4	Poor	Good	Poor.[3]
Shale	Garo	A–7	Very poor	Poor	Poor.
Shale	Trout Creek	A–7	Very poor	Poor	Poor.
Trachyte	Buena Vista	A–2	Very good	Good	Poor.

[1] Texture and other characteristics extremely variable. [2] Unsuitable for construction purposes. [3] Shallow to bedrock.

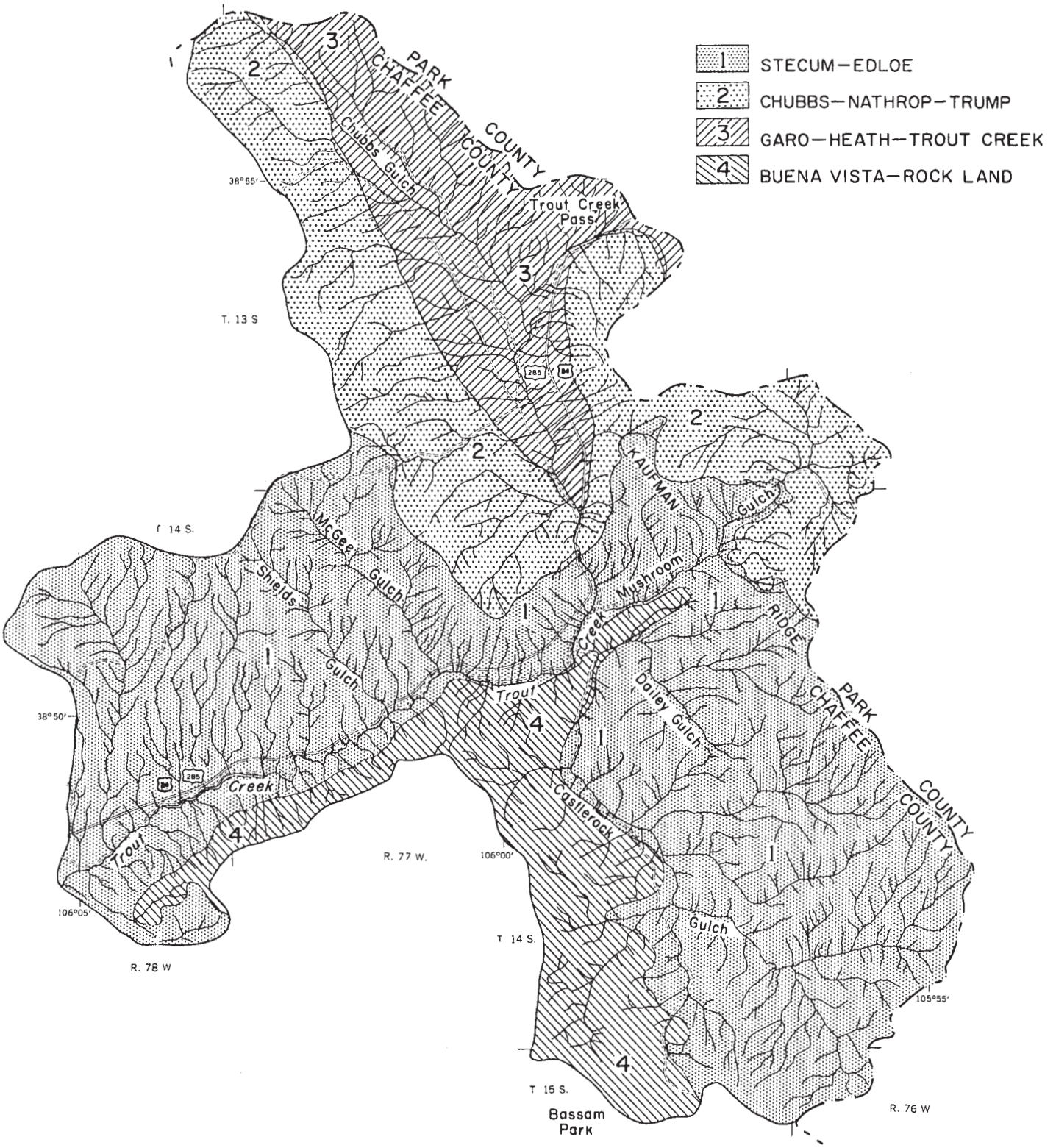

Figure 9.—**Map of soil management areas.**

TABLE 11.—*Summary of major characteristics of soil management areas*

Management area		Component soils		Parent rock	Soil pattern	Drainage pattern	Dominant relief
Name	Percent of watershed	Name of series and land types	Percent of management area				
1. Stecum-Edloe	54. 2	Stecum	60. 9	Dominantly granite.	Complex	Dendritic; many deep channels and gullies.	Moderately steep to rough; highly dissected.
		Edloe	13. 4				
		Alluvial land	11. 0				
		Rock outcrop	6. 6				
		Rock land	5. 7				
		Bassel	1. 9				
		Buena Vista	. 5				
2. Chubbs-Nathrop-Trump.	20. 3	Chubbs	48. 8	Dominantly limestone.	Simple; uniform.	Lattice; few drainageways.	Moderately steep to steep; uniform slopes.
		Laporte, Nathrop, and Trump.[1]	30. 0				
		Stony land, Chubbs materials.	16. 2				
		Alluvial land	3. 0				
		Garo	2. 0				
3. Garo-Heath-Trout Creek.	13. 3	Heath	35. 0	Dominantly shale and sandstone.	Simple; uniform.	Dendritic; few drainageways.	Moderately sloping to steep.
		Trout Creek	35. 0				
		Garo	20. 0				
		Alluvial land	4. 0				
		Rock land	3. 5				
		Wellsville	2. 0				
		Laporte, Nathrop, and Trump.[1]	. 5				
4. Buena Vista-Rock land.	12. 2	Rock land	45. 0	Dominantly trachyte and tuff.	Simple; uniform.	Dendritic; weakly developed.	Steep (tablelands and escarpments).
		Buena Vista	33. 6				
		Alluvial land	7. 0				
		Chubbs	6. 0				
		Stecum	5. 0				
		Stony land, Buena Vista materials.	2. 4				
		Laporte, Nathrop, and Trump.[1]	1. 0				

[1] Soils of these three series were mapped only as a complex and are not shown individually on the soil map.

valuable primarily for broad planning purposes and have relatively little use for detailed planning and operations.

1. Stecum-Edloe area

Shallow, highly erodible, gravelly and sandy soils of low to medium fertility and low water-holding capacity dominate in this area. The relief is moderately steep or rough, and strongly dissected. Almost all the area is underlain by granite in which there are small inclusions of biotite schist. The granite is near the surface, and outcrops of bedrock are prominent on the landscape (fig. 10). Rimrock and steep rock land are extensive in some parts of the area.

Numerous deep channels that form a dendritic pattern characterize the drainage system. Most of the drainageways on the Edloe soils are stable and have only a few secondary tributaries; many of those on the Stecum soils are unstable and have many small tributaries. Except for the lower reaches of the main channel of Trout Creek, all the drainageways are intermittent. Surface drainage is good to excessive. The fine texture of the drainage system is the result of rapid, heavy runoff that quickly concentrates and cuts new channels.

As shown in table 12, this area has more miles of drainageways per square mile than any of the other three management areas. Many miles of drainageways are unstable or gullied. North of Trout Creek there are 166.4 miles of unstable drainageways, and south of the creek, only 29.4. The area south of the creek has denser vegetation and slower runoff than the other parts of the area.

The number of unstable drainageways in each area is closely related to the degree of erosion. Loss of surface soil reduces the rate of infiltration and decreases the water-holding capacity. The result is increased surface runoff, which creates gullies and overburdens the drainageways to a point where they become unstable.

Much of the acreage is moderately to severely eroded. The parts at the lowest elevations have had the most intensive use and are seriously eroded. Edloe soils, which have northerly exposures, have a denser cover of vegetation than other soils in the management area and are only slightly eroded.

At the lower elevations and on the southerly exposures, the vegetation consists of thin stands of pinyon and juniper trees and many open grassy areas. The sparse understory is mostly ring muhly, blue grama, and Indian ricegrass. At the higher elevations and on the northerly exposures grow scattered spruce, Douglas-fir, ponderosa pine, and quaking aspen trees.

This area occupies 54.2 percent of the watershed. The soil pattern is complex. In many places Edloe and Stecum

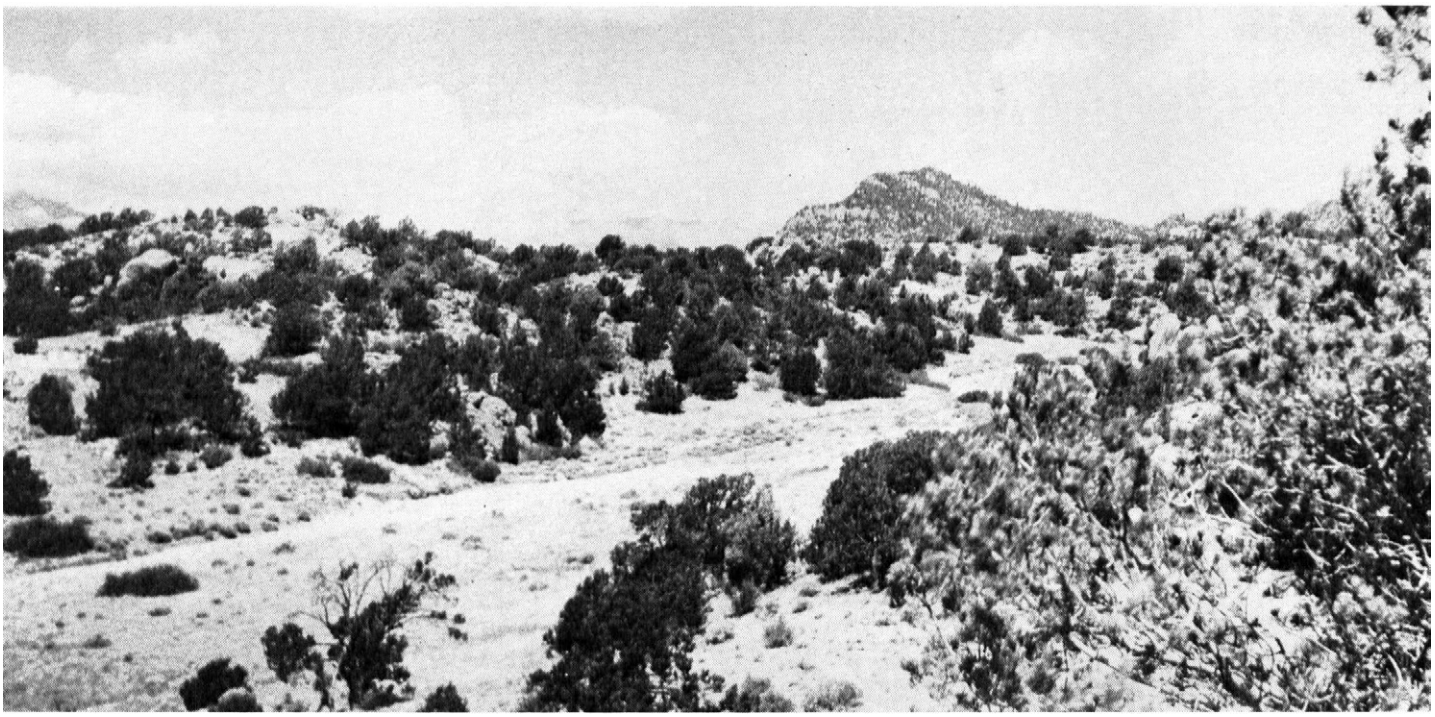

Figure 10.—**Characteristic landscape in the Stecum-Edloe soil management area.**

soils are closely associated, the Edloe soils occupying the northerly exposures and the Stecum soils the southerly exposures. The part of the area north of Trout Creek is 60 percent Stecum soils, 25 percent Rock outcrop, 12 percent Alluvial land, and 3 percent Edloe and Bassel soils. The part south of Trout Creek is 43 percent Stecum soils, 25 percent Edloe soils, 20 percent Rock land and Rock outcrop, 10 percent Alluvial land, and 3 percent Buena Vista and Bassel soils. The principal difference between the northern and southern parts of this area is that the Edloe soils, which have northerly exposures, occur mostly in the southern part. There are no significant differences in management requirements.

In general, the level of fertility is low, although Alluvial land is productive of grass and trees. The Stecum and the Edloe soils are poor to fair for herbage and very poor to only fair for timber. The Edloe soils provide more areas that might successfully be revegetated than do the Stecum soils. Alluvial land and the Bassel soils are well suited to herbage.

Except for Alluvial land and the Bassel soils, the soils and the underlying unconsolidated material have a low capacity to store water for slow release to springs and streams.

This area is useful principally for sustained water yield, for recreation, and as shelter for wildlife, principally deer (fig. 11).

A primary management need is soil protection—that is, maintaining and improving the quality and density of the vegetation so as to reduce runoff and control erosion. Unmanaged grazing and the harvesting of trees can be generally detrimental. Economic returns from reseeding ranges

TABLE 12.—*Miles of drainageways in each soil management area, and average length and number of tributaries*

[Unstable drainageways measured with a map measurer on 1:12,000 soil map; other measurements made with same instruments on 1:31,680 Ozalid soil map]

Soil management area	Drainageway distance			Average length of primary tributary	Average number of secondary tributaries on primary tributary	
	Per square mile	Total in management area	Total unstable in management area		More than ¼ mile long	Less than ¼ mile long
	Miles	*Miles*	*Miles*	*Miles*		
1. Stecum-Edloe	13. 25	419	[1] 195. 8	2. 75	21	31
2. Chubbs-Nathrop-Trump	5. 25	62	[2] 6. 5	1. 00	3	4
3. Garo-Heath-Trout Creek	10. 00	77	[3] 46. 2	1. 25	3	7
4. Buena Vista-Rock land	5. 25	37	21. 7	. 75	3	4

[1] 50.6 miles in main channels. [2] 3.6 miles in main channels. [3] 23.6 miles in main channels.

Figure 11.—**Stecum soils; rocky terrain provides concealment for deer.**

or from reforestation generally cannot be expected under present levels of management, but it may be advisable to plant grass or trees to protect the watershed. Table 8, p. 32, shows which of the soils in this management area are best for these purposes.

2. Chubbs-Nathrop-Trump area

Fertile, stable, shallow, and moderately deep soils are dominant in this soil management area. Along entrenched drainageways, the slopes are steep; elsewhere, they are moderately steep and uniform. Limestone bedrock underlies the soils, and in spots the soils are very stony or rocky. There are several flowing springs and a number of seeps.

The drainage system is generally coarse textured and has a lattice-type pattern. The soils in this area have higher water-holding capacity, gentler and more uniform slopes, and greater stability than those in the Stecum-Edloe area; consequently, fewer drainageways have formed. Much water passes through the soils rather than over the surface. Surface drainage is good, although parts of the area are relatively level.

The erosion hazard is slight to moderate, except on very steep, south-facing slopes and on recently burned-over areas, both of which are uncommon. There has been almost no gullying of drainageways.

The vegetation is an open forest of conifers, mostly spruce, Douglas-fir, ponderosa pine, and quaking aspen on the north-facing slopes. Open grassy areas are more common on the southerly exposures.

This area occupies 20.3 percent of the watershed. An estimated 30 percent of the area consists of Laporte, Nathrop, and Trump soils; 48.8 percent consists of Chubbs clay loam; and 16.2 percent of Stony land, Chubbs materials. The remaining 5 percent consists of Alluvial land and Garo soils. The Chubbs soil is generally on north-facing slopes. The soil pattern is, for the most part, simple and uniform. A complex pattern of Laporte, Nathrop, and Trump soils occurs on some south-facing slopes.

The Trump and the Laporte soils are shallow, but the other soils in the area are moderately deep to deep and have a high capacity for supplying moisture to plants. As a whole, the area has a medium to high capacity for sustained yield of water. The soils are moderately productive of herbage and of ponderosa pine and Douglas-fir. The soil material is suitable for use in water-retaining structures and other engineering structures, but because the bedrock is near the surface, sites for proposed structures should be carefully studied.

In general, management requirements are far less exacting than for the Stecum-Edloe area. Water yield,

timber, and forage are the highest use potentialities. The gentler slopes can be used for timber and forage, but trees should rarely be harvested from steep, south-facing slopes until better methods are available. Management of grassland should be such as to encourage the natural reestablishment of vegetation and to maintain a good herbaceous cover. The vegetation recovers rapidly if protected.

3. Garo-Heath-Trout Creek area

Long, uniform, grass-covered slopes and a series of low, roughly parallel ridges are the outstanding features of the landscape in this area (fig. 12). The slopes are moderate to steep; the steep slopes are along drainageways. Shale or interbedded sandstone and shale underlie most of the area.

In miles of drainageways per square mile, this area is second to the Stecum-Edloe area (see table 12). Sixty percent of the drainage mileage is unstable. New drainageways form readily wherever water concentrates. Over most of the area, surface runoff is medium. In places the underlying shale deflects water toward the surface; consequently, there are a few seeps. The drainage pattern is fine textured and dendritic.

The Trout Creek, Heath, and Garo soils are very unstable and have been seriously eroded and gullied.

The vegetation is predominantly grass. Spruce trees and scattered ponderosa pine trees grow in some areas.

This area occupies 13.3 percent of the watershed. It is 35 percent Trout Creek soils, 35 percent Heath soils, 20 percent Garo soils, 2 percent Wellsville soils, and 4 percent Alluvial land. The rest is Rock land and a small acreage of the Laporte-Nathrop-Trump complex.

The soil pattern is simple and uniform, but the soils are strongly contrasting. The Trout Creek and the Heath soils are moderately fertile and have good moisture-holding capacity. They are moderately sloping to steep, but the slopes are generally long and uniform. The Garo soils are on the ridges and hilltops. They are shallow and stony. Long lines of rock outcrops are common, but the outcrops are less prominent than those in the Stecum-Edloe area. The fertility of the Garo soils is moderate. Also in the area are the Wellsville soils. These are deep and productive but so inextensive that they do not significantly affect use and management.

Management requirements are exacting. Sustained yield of water and production of herbage are the highest use potentials. The capacity for sustained yield of water is low. Much of the acreage is in need of reseeding. Management might well be directed toward encouraging the natural reestablishment of the grasses and subsequently maintaining a good cover of grasses. Reestablishing grass in the eroded parts of the area will be difficult. Much of the acreage needs to be protected from use for a long time, and most of the rest can stand only limited grazing. The shale soils are particularly susceptible to damage by trampling when wet.

Because of the instability of the soils that developed over shale, extreme care should be taken in using these soils in earth structures.

4. Buena Vista-Rock land area

Grassy tablelands that have steep, rocky, sparsely timbered escarpments are prominent features of the landscape in this area (fig. 13). On the top of the mesas, the relief is undulating to rolling. Except on the rims of the mesas and in other very steep spots, the soils are moderately deep. Trachyte and tuff underlie most of the area; lime-

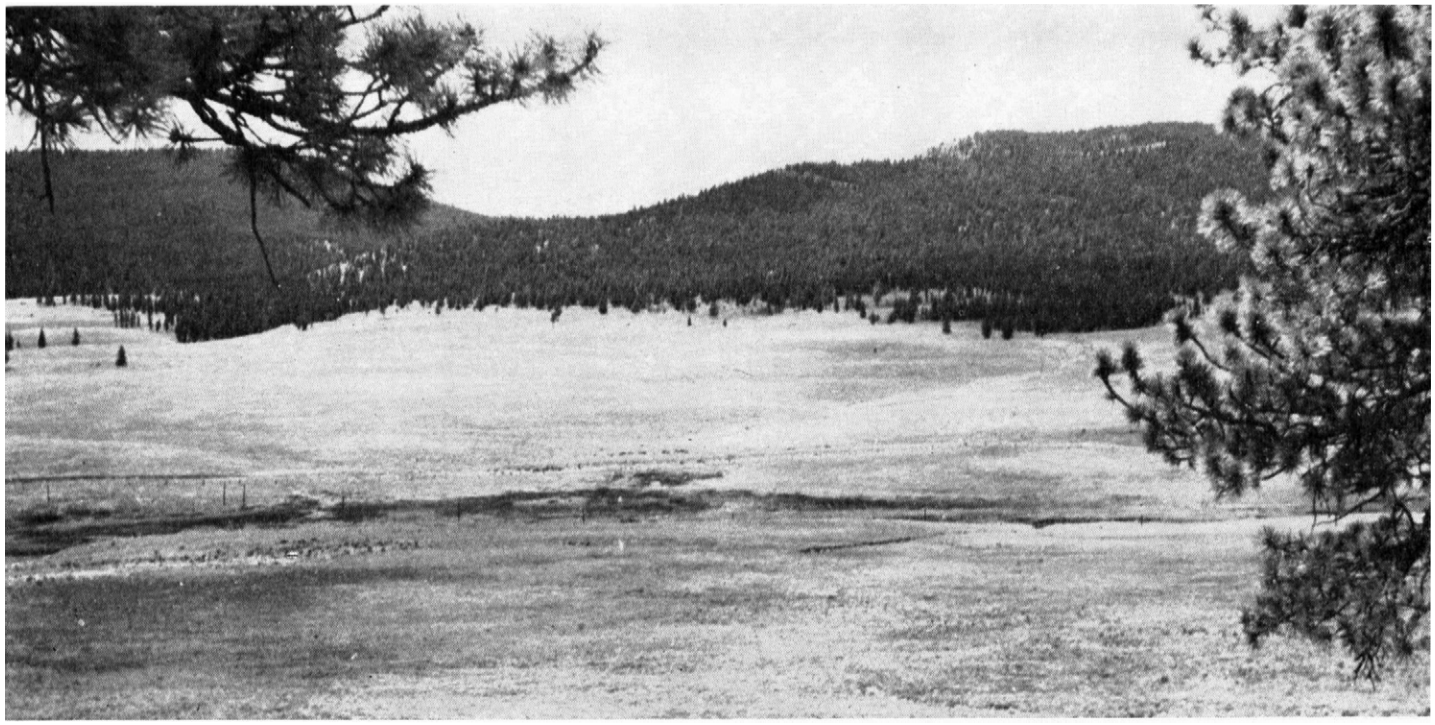

Figure 12.—Long, uniform, grass-covered slopes, characteristic of the Garo-Heath-Trout Creek soil management area.

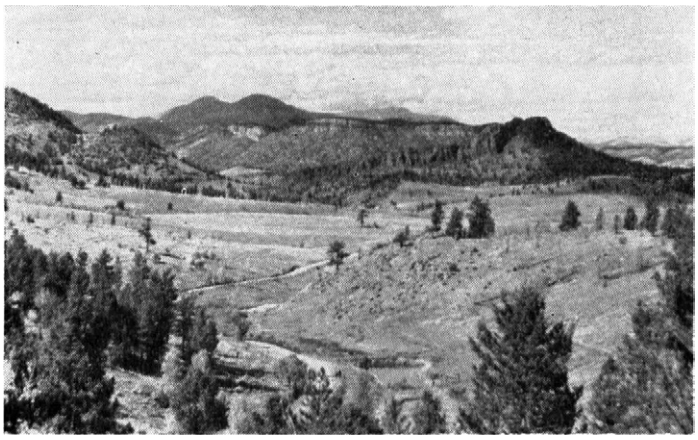

Figure 13.—**Grassy tablelands and rocky, sparsely timbered escarpments in the Buena Vista-Rock land soil management area.**

stone and granite underlie a small part of it, and there is one minor inclusion of quartzite.

The drainage system is not well developed. Drainageways are few (see table 12), and in places there is practically no drainage pattern. Surface drainage is generally good; on the escarpments it is excessive. Except on the steep slopes, there is little runoff, because surface water infiltrates rapidly. On the undulating to rolling mesa tops, some of the surface water drains into small natural depressions. Several springs and seeps emerge near the base of the mesa rims.

The inherent erodibility is only moderate, largely because of rapid permeability. Erosion has done only minor damage, except in the vicinity of Castlerock Gulch where there has been intensive use of the soils.

The vegetative cover is partly grass and partly open forest.

This management area occupies only 12.2 percent of the watershed. It is 45 percent Rock land, 36.6 percent Buena Vista soils, 7 percent Alluvial land, 6 percent Chubbs soils, and 2.4 percent Stony land, Buena Vista materials. The rest consists of Stecum soils and the Laporte-Nathrop-Trump complex. The Chubbs, Laporte, Nathrop, and Trump soils are underlain by limestone, and the Stecum soils by granite. The soil pattern is simple and uniform.

The soils in this management area are loose, porous, and very stony. The fertility is medium, and the productivity is low to medium. Water infiltrates and percolates rapidly, but only a small amount of moisture is retained where it is available to plants. The capacity for sustained yield of water to springs and streams is excellent, because both the soils and the regolith are permeable.

This area is fair for herbage and poor for timber. The steep slopes and the shallow, very stony soils present serious problems in any program for reseeding grasses or planting trees. Some areas would produce herbage and ponderosa pine and Douglas-fir, but, in general, management could best be directed toward increasing the water yield, making the area a better habitat for deer, and improving the vegetative cover so that it will continue to protect the soils.

Generally, the soils are not suitable for use in earth structures, because they contain too little clay to bind the coarser particles together.

Management Groups

A management group is made up of soils that are about the same in use suitability and in management needs but may or may not be geographically associated. The groupings are solely for convenience in discussion; they do not indicate that the soils in a group can be managed as a unit. For example, the soils in group 1 are well suited to herbage, but many small acreages of these soils occur within large areas of soils better suited to recreation and the protection of wildlife and are managed for those uses as part of the larger areas. Suggestions that apply to geographic associations of soils are given in the section, Soil Management Areas.

The suggestions in this section are based on the known characteristics and qualities [6] of the soils and on observations of the behavior of soils, either in research trials or in normal use. Only general practices are discussed.

Management group 1

The land types that make up this management group are good to excellent for herbage and very poor to good for timber. They have a high capacity for sustained water yield. They are deep and have a good supply of moisture for plants most of the time. The group consists of—

Alluvial land.
Peat, muck, and alluvial land.

Except for the peaty areas, the fertility level is high. In places, the supply of plant nutrients is replenished periodically by flood sediments. All areas are high in organic matter. The peat and muck have high water tables. The hazard of erosion, especially of gullying, is severe. Considerable damage in the form of streambank cutting and deposition of raw material is caused by runoff and flash floods from the uplands.

The management requirements of this group are simple, compared with those of the other management groups. Controlling erosion is largely a problem of reducing runoff from the uplands. Building storage dams in main channels to impound water and allow it to spread over the meadows will help to build up the water table. Caving of streambanks and deepening of the channels can be controlled to some extent by building dams and by planting woody and shrubby plants on the bottoms and sides of the streams. Sloping the gully banks to the angle of repose before planting will help keep the banks from caving in and will hasten stabilization. Revegetating selected spots along the banks of the streams will protect and improve the streams as habitats for fish.

Except for the areas that are in soil management area 3 (Garo-Heath-Trout Creek), these land types are physically suitable for habitats for beaver, but the supply of food is limited. Beaver should be removed and kept out, at least until the food supply increases. The failure of a beaver dam can cause considerable damage to a stream channel.

Some erosion has taken place in roads, skid trails, and livestock trails. In most places the vegetation will recover if grazing is reduced, but some areas will need to be reseeded. Seeding has been unsuccessful in peaty areas that have been drained by the deepening of channels.

[6] Soil characteristics are observable properties (color, texture, structure), and soil qualities are inferred properties (fertility, permeability, moisture-holding capacity, and so forth) (*1*).

Management group 2

The soils in this group are fair to good for herbage but poor to fair for timber. The group consists of—

Bassel sandy loam.
Buena Vista very stony sandy loam.
Buena Vista very stony sandy loam, eroded.
Garo clay loam.
Heath loam and clay loam.
Heath clay loam, eroded.
Trout Creek loam.
Trout Creek clay loam, eroded.
Wellsville very fine sandy loam.

The capacity for sustained water yield is high in the Bassel, Buena Vista, and Wellsville soils; medium in the Heath and Trout Creek soils; and low in the Garo soil. In the Wellsville soil, the capacity to supply moisture to plants is high; in the rest of the soils it ranges from medium to low. The general fertility level is moderate, but it ranges from very low for the eroded Buena Vista soil to moderately high for the Wellsville soil.

All of these soils are moderately to highly erodible. The erosion hazard is particularly high in the Garo, Heath, and Trout Creek soils, which developed from shale.

The Wellsville soil is inextensive compared to the other soils in the group.

In some places the native herbaceous cover is so depleted that most of the desirable native grasses have been eliminated. In such places reseeding may be necessary, but several problems need to be considered before such work is undertaken. Only the better soils should be reseeded. The Buena Vista soils are particularly difficult to reseed because they are stony, droughty, erodible, and difficult to work with ordinary machinery. The risk of failure is high on the Buena Vista soils, so if any covering of the native plants remains it is better to limit grazing than to reseed (*4*). Even where reseeding appears justifiable, the risk of failure is high because most of the soils are droughty. Seasonal rainfall is erratic, consequently the timing of seedbed preparation and seeding is critical. Failure may leave bare soils exposed for long periods to surface erosion. Many of the soils develop a hard crust upon drying. Slopes of more than 20 percent should not be plowed. Seedbed preparation and drilling should be on the contour for best results. Supporting structures, such as contour furrows, terraces, or small check dams, may be desirable on some soils to control runoff and erosion until a cover is established.

The Garo, Heath, and Trout Creek soils should not be grazed when wet, because they are particularly susceptible to damage by trampling. Because the soils, in general, are somewhat droughty, it is particularly important to regulate the time of grazing.

The soils in this group are not well suited to timber, and they have relatively limited potential for use as recreational areas or wildlife habitats.

Management group 3

The soils in this group are poor to very poor for forage, very poor for timber, and high to low in capacity for sustained yield of water. The group consists of—

Bassel sandy loam, severely eroded.
Buena Vista very stony sandy loam, severely eroded.
Garo clay loam, severely eroded.

All of these soils are very low in fertility and highly erodible. Excessive runoff, slow infiltration, lack of organic matter, and droughtiness are common characteristics. Most of the acreage is on warm, south-facing slopes, where much moisture is lost through evaporation. The surface of these soils swells when wet and becomes hard and crusted when dry. Because of these unfavorable characteristics and qualities, revegetating these soils with grasses is extremely difficult (fig. 14). Timber plantings are not recommended.

All of these soils are within areas that are managed mainly for herbage, but they all need some protection from grazing so that a good vegetative cover can be established. Fencing and reseeding are desirable management practices. Seedbed preparation and drilling should be on the contour. Complete removal of existing vegetation should be avoided, if possible. Supporting engineering structures would help to control or divert runoff and keep the soils stable enough for the new vegetation to become established. Contour furrows and terraces may be needed in places. All such structures should be suitably located and properly constructed, because the soils are very unstable. Improperly constructed terraces, outlets, and spillways can cause serious gullying in these soils. Already there are many active gullies that require stabilization by revegetation and structures. Small check dams in the gullies will control the moisture supply somewhat and thus help to get vegetation established. Nitrogen fertilizer might improve the seeded stands, but, because of droughtiness, fertilizer may do no good at all. A mulch helps new seedings to get started, but mulching large areas may be impractical.

The soils in this group have little potential use as recreational areas or wildlife habitats.

***Figure 14.*—Garo clay loam, severely eroded; an example of soils in management group 3 that are difficult to revegetate.**

Management group 4

The soils in this group are poor to fair for timber. Most of them are good for herbage. Their capacity for sustained yield of water ranges from low to medium and is predominantly medium. The group consists of—

Chubbs clay loam.
Edloe gravelly sandy loam.
Stony land, Chubbs materials.
Laporte-Nathrop-Trump complex.

These are generally stable, fertile soils that have good moisture-supplying capacity. They are mostly deep but rocky. Some Rock land, which consists of exposed rock and very shallow soil, is included in the Laporte-Nathrop-Trump complex.

Although clay loam textures predominate, the soils are friable and are permeable to air and water. Next to a few of the drainageways there are some steep slopes, but generally the slopes are moderate, long, and uniform; level areas are common. Only the very steep, south-facing slopes are eroded, and there are practically no gullies.

These soils should be managed for water storage, timber production, and herbage production, in that order of importance.

The Edloe and Chubbs soils are on north-facing slopes where the moisture-supplying capacity is good. Commercial thinning of timber is desirable on these soils. All slash should be lopped and scattered. Conservative grazing is desirable where the condition of the range is good or better. Natural revegetation is fairly rapid, but planting or seeding may be advisable in some areas. New seedings have a good chance of succeeding.

The Laporte-Nathrop-Trump complex occupies steep, south-facing slopes that are somewhat droughty. Trees can best be used for soil protection. If cutting is necessary for control of insects or diseases, the logs should not be salvaged by present conventional methods, nor should logs be salvaged after fires. Except where grasses are abundant, grazing should be kept to a minimum so that it will not interfere with natural revegetation and the maintenance of a good herbaceous cover for soil protection. Natural revegetation is slow. Reseeding may be advisable for some areas, but will not be as successful as on northerly exposures. In the rocky areas, the seed would have to be broadcast.

Management group 5

Most of the soils and land types in this group are poor for herbage and timber and have low capacity for sustained yield of water. The group consists of—

Laporte-Nathrop-Trump complex, severely eroded.
Stecum sandy loam, 0 to 8 percent slopes.
Stecum sandy loam, 0 to 8 percent slopes, eroded.
Stecum sandy loam, 8 to 40 percent slopes.
Stecum sandy loam, 8 to 40 percent slopes, eroded.
Stecum sandy loam, 8 to 40 percent slopes, severely eroded.
Stony land, Buena Vista materials.
Rock land.
Rock outcrop.

The Stecum soils were derived from granite; the Buena Vista materials were derived from trachyte and tuff; Rock land and Rock outcrop consist of a variety of rock materials.

This group is characterized by low fertility, low productivity, and low moisture-holding and moisture-supplying capacity. The soils are sandy, shallow, droughty, and unstable. Outcrops are numerous, and some are large. The slopes are moderate to steep, and the areas are strongly dissected by numerous drainageways. The surface is moderately to severely eroded, there are many active gullies, and many of the drainageways are unstable.

These soils should be managed for soil protection, water storage, development of recreational areas, and restoration of the wildlife habitats. For lumbering and grazing their value is very low, and these uses are generally detrimental. The tree cover should be maintained for protection. Timber should not be removed from the Stecum soils that have slopes of more than 8 percent, or from the stony and rocky land types, or from steep, south-facing slopes. Grazing is generally detrimental. Reseeding or reforesting is difficult and is not likely to bring economic returns, but one or the other may be advisable for protection of the watershed. The chance of successful revegetation is best on the Stecum soils that have slopes of 8 percent or less. Revegetation of the severely eroded Stecum soil has little chance of being successful. Both revegetation and engineering structures would help stabilize the active gullies.

The soils in this group provide a good environment for wildlife. Mule deer are the most numerous of the big-game animals. There are a few elk, mountain sheep, and black bear. Beaver have occupied extensive sections of the streams at times. At present, there are almost no fish. To assure a supply of food for game, the uplands should be revegetated with shrubs suited to the soils. Woody and shrubby plants should be planted in stream bottoms and aspens and willows on streambanks. Beaver should be kept out until there are enough aspens and willows to support a limited number of them. Revegetation of the streambanks and the installation of small check dams will improve the streams for fish. Restoring the areas at the lower elevations should have priority because these are the areas that make the best winter habitats.

Revegetation and restoration of the fish and game habitats will add to the recreational value of these areas. Picnic grounds and campgrounds with space for trailers are needed. Recreational developments can best be placed on nearly level or gently sloping soils that are well drained and not in danger of being flooded. Medium-textured soils are best; coarse-textured soils are easily disturbed and are likely to be damaged by wind erosion, and the fine-textured soils become compacted. The detailed soil map will be helpful in picking out suitable sites.

Glossary

Acidity. See Reaction.

Afforestation. Establishment of a forest on an area not previously forested.

Alluvium. Sand, mud, and other sediments carried by water and deposited on low land by streams.

Aspect. (1) The direction toward which a slope faces; the exposure. (2) The overall physical appearance of a plant type.

Bedrock. The solid rock underlying soils.

Calcareous soil. Soil containing sufficient calcium carbonate (lime), often mixed with magnesium carbonate, to effervesce (bubble) visibly when treated with cold, dilute (0.1 N) hydrochloric acid.

Clay. (1) As a soil separate, mineral particles less than 0.002 millimeter (0.000079 inch) in diameter. (2) As a textural class,

soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Complex, soil. Two or more kinds of soil mapped as a unit because the soils occur in such an intricate pattern or in individual areas so small that they cannot be shown separately on the soil map.

Colluvium. Mixed deposits of soil material and rock fragments that have been moved by gravity and deposited near the base of rather strong slopes. The deposits may have been moved by soil creep, slides, or free fall.

Consistence, soil. An attribute of soil material that is expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture. Terms commonly used to describe consistence are as follows:

Brittle. When dry, will break with a sharp, clean fracture, or, if struck a sharp blow, will shatter into cleanly broken, hard fragments.

Compact. Dense and firm but not cemented.

Very compact. Very dense and very firm but not cemented.

Firm. Crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Very firm. Crushes under strong pressure; barely crushable between thumb and forefinger.

Friable. Crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together.

Very friable. Crushes under very gentle pressure but coheres when pressed together.

Loose. Noncoherent. No resistance to deforming pressure.

Plastic. Wire formable; moderate pressure required for deformation of the soil mass.

Very plastic. Wire formable; much pressure required for deformation of the soil mass.

Erosion, soil. The wearing away or removal of soil material by running water, by wind, or by other geological agents.

Forest. Land bearing a stand of trees of any age or stature, including seedlings, of species that attain a minimum average height of 6 feet at maturity; or land from which such a stand has been removed but which is not now restocking and which has been put to no other use. Forest on farms is called farm woodland or farm forest.

Fertility, soil. The quality that enables a soil to provide the proper nutrient compounds, in the proper amounts and in the proper balance, for the growth of specified plants when other factors, such as light, temperature, and the physical condition of the soil, are favorable.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding; land along a stream that is subject to overflow.

Great soil group. A broad group of soils that have fundamental characteristics in common.

Horizon, soil. A layer or part of the soil profile, approximately parallel to the land surface, that has distinct characteristics produced by soil-forming processes.

Horizon, A. The upper horizon of the soil mass from which material has been removed by percolating water; the eluviated part of the solum; the surface soil. It is generally subdivided into two or more subhorizons (A_1, A_2, and so on). An A_0 is not a part of the mineral soil but an accumulation of organic debris on the surface.

Horizon, B. A soil horizon, usually beneath an A horizon, in which (1) clay, iron, or aluminum, with accessory organic matter, have accumulated by receiving suspended material from the A horizon or by clay development in place; (2) the soil has a blocky or prismatic structure; or (3) the soil has some combination of these features. In soils with distinct profiles, the B horizon is roughly equivalent to the general term "subsoil."

Horizon, C. The horizon of partly weathered material underlying the B horizon; the substratum; usually the parent material.

Internal drainage. The movement of water through the soil profile. The rate of movement is affected by the texture and structure of the surface soil and subsoil and by the location of the water table, either permanent or perched. Relative terms for describing internal drainage are the following: very rapid, rapid, medium, slow, very slow, and none.

Landscape. The sum total of the characteristics that distinguish a certain area on the earth's surface from other areas. These characteristics are the results not only of natural forces but of human occupancy and use of land. Included are such features as soil types, vegetation, rock formations, hills, valleys, streams, cultivated fields, roads, and buildings (*12*).

Leaching, soil. Removal of materials in solution by percolating water.

Loam. Soil consisting of about equal proportions of sand, silt, and clay.

Miscellaneous land type. An area that has little or no true soil.

Morphology. The physical constitution of the soil, including the texture, structure, consistence, porosity, color, and other physical and chemical properties of the various horizons in the soil profile.

Mottles, soil. Contrasting color patches that vary in number and size; usually associated with poor drainage. Descriptive terms are as follows: contrast—faint, distinct, and prominent; abundance—few, common, and many; and size—fine, medium, and coarse. The size measurements are as follows: fine, commonly less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, commonly between 5 and 15 millimeters (about 0.2 to 0.6 inch) along the greatest dimension; and coarse, commonly more than 15 millimeters (about 0.9 inch) along the greatest dimension (*8*).

Natural drainage. Conditions that existed during the development of the soil; opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be due to other causes, such as sudden deepening of channels or sudden blocking of drainage outlets. The following relative terms are used to describe natural drainage: excessive, somewhat excessive, good, moderately good, imperfect or somewhat poor, poor, and very poor.

Normal soil. A soil having a profile nearly in equilibrium with its environment; developed under good but not excessive drainage from parent material of mixed mineral, physical, and chemical composition; has been in place long enough for biological forces to exert their full effect.

Nutrients, plant. The elements taken in by the plant, essential to its growth, and used by it in the elaboration of its food and tissue. These include nitrogen, phosphorus, calcium, potassium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps others obtained from the soil; and carbon, hydrogen, and oxygen, obtained largely from the air and water.

Order, soil. The highest category in soil classification. The three orders are zonal soils, intrazonal soils, and azonal soils.

Parent material. The unconsolidated mass from which the soil profile develops. (See Horizon, C.)

Ped. A natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod, which is a mass of soil resulting from digging or other disturbance.

Permeability, soil. That quality of the soil that enables it to transmit water or air.

Phase, soil. A subdivision of a soil type, usually based on external characteristics, such as relief, accelerated erosion, or stoniness.

Productivity, soil. The capacity of a soil to produce a specified plant or sequence of plants under a defined set of management practices.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. (See Horizon, soil.)

Reaction. The degree of acidity or alkalinity of the soil mass; expressed in words and pH values as follows:

	pH[1]
Extremely acid	Below 4.5.
Very strongly acid	4.5 to 5.0.
Strongly acid	5.1 to 5.5.
Medium acid	5.6 to 6.0.
Slightly acid	6.1 to 6.5.
Neutral	6.6 to 7.3.
Mildly alkaline	7.4 to 7.8.
Moderately alkaline	7.9 to 8.4.
Strongly alkaline	8.5 to 9.0.
Very strongly alkaline	9.1 and higher.

[1] Strict neutrality is pH 7.0.

Relief. The elevations or inequalities of a land surface, considered collectively.

Revegetation. The reestablishment or improvement of a plant cover, either naturally or through reseeding or transplanting.

Sand. As a soil separate, rock or mineral fragments 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch) in diameter. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils that, except for texture of surface soil, are similar in profile characteristics and horizon arrangement, and have developed from the same kind of parent material. (See Type, soil, and Phase, soil.)

Silt. As a soil separate, mineral grains 0.002 millimeter (0.000079 inch) to 0.05 millimeter (0.002 inch) in diameter. As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slash. Debris left after logging, pruning, thinning, or brush cutting; also debris left by wind or fire.

Soil. A natural body on the surface of the earth characterized by conformable layers resulting from modification of parent material by physical, chemical, and biological forces over periods of time; the natural medium for the growth of land plants.

Soil separates. The individual size-groups of mineral particles. (See Sand, Silt, and Clay.)

Soil, textural class. A classification based on the relative proportion of soil separates. The basic classes in order of increasing proportions of the fine separates are sand, loamy sand, sandy loam, loam, silt loam, and silt.

Structure, soil. The arrangement of the individual grains into aggregates that have a definite shape or pattern. May refer to the natural arrangement of the soil when in place and undisturbed or to the soil at any degree of disturbance. Soil structure is classified according to grade, class, and type.

Grade. Degree of aggregation, or the differential between cohesion within aggregates and adhesion between aggregates. Terms: structureless (single grain or massive), weak, moderate, and strong.

Class. Size of soil aggregates. Terms: very fine or very thin, fine or thin, medium, coarse or thick, and very coarse or very thick.

Type. Shape of soil aggregates. Terms: platy, prismatic, columnar, blocky, nuciform or nutlike, granular (nonporous), and crumb (porous). Principal types of structure in this survey area are the blocky and the crumb. In fine blocky structure, peds (aggregates) are 5 to 10 millimeters (0.2 to 0.4 inch) in size; in medium blocky, 10 to 20 millimeters (0.4 to 0.8 inch); and in coarse blocky, 20 to 50 millimeters (0.8 to 2.0 inches). In fine crumb structure, peds are 1 to 2 millimeters (0.04 to 0.08 inch) in size, and in medium crumb structure, 2 to 5 millimeters (0.08 to 0.2 inch).

Subsoil. Technically, the B horizon; roughly, that part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil. (See Horizon, C and Parent material.)

Surface soil. Technically, the A horizon; commonly, the part of the upper profile usually stirred by plowing.

Sustained water yield. The amount of water that the soil and underlying material will store and release slowly through springs and seeps to maintain a sustained flow in streams; in contrast with flood yields and surface runoff following storms or rapid snowmelt.

Texture. The relative proportions of the various size groups of individual soil grains in a mass of soil. A coarse-textured soil is one high in sand; a fine-textured soil is high in clay.

Type, soil. A subdivision of a soil series, based on texture of the surface soil.

Water spreading. Diversion of water from a watercourse onto gently sloping and absorptive soils to conserve waste water, reduce flood peaks, and build up or replenish the ground water.

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GUIDE TO MAPPING UNITS AND MANAGEMENT GROUPS

Growth Through Agricultural Progress

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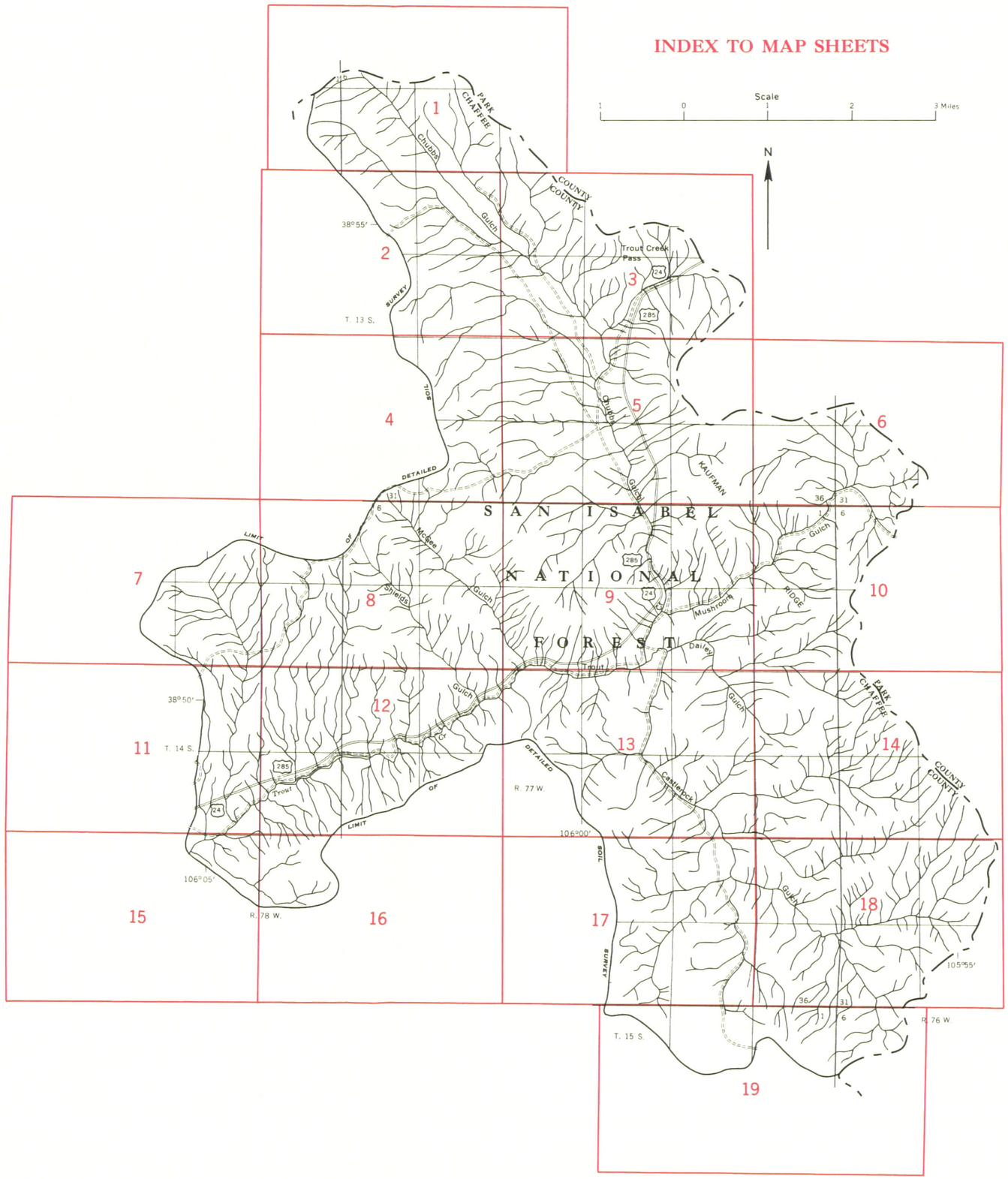
TROUT CREEK WATERSHED, COLORADO

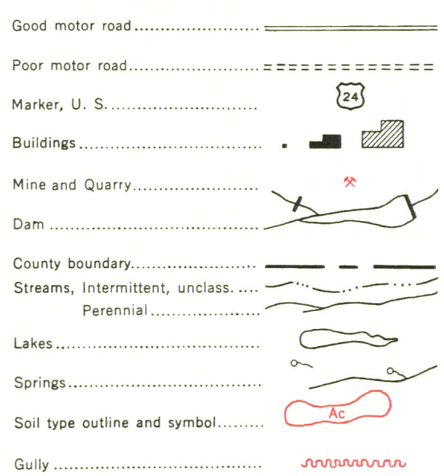
INDEX TO MAP SHEETS



SOIL LEGEND

SYMBOL	NAME
Av	Alluvial land
Ba	Bassel sandy loam
Bd	Bassel sandy loam, severely eroded
Bs	Buena Vista very stony sandy loam
Bv	Buena Vista very stony sandy loam, eroded
By	Buena Vista very stony sandy loam, severely eroded
Ch	Chubbs clay loam
Ed	Edloe gravelly sandy loam
Ga	Garo clay loam
Ge	Garo clay loam, severely eroded
He	Heath clay loam, eroded
Hm	Heath loam and clay loam
Ln	Laporte-Nathrop-Trump complex
Lt	Laporte-Nathrop-Trump complex, severely eroded
Pm	Peat, muck, and alluvial land
Rc	Rock land
Ro	Rock outcrop
Sc	Stecum sandy loam, 0 to 8 percent slopes
Se	Stecum sandy loam, 0 to 8 percent slopes, eroded
Sm	Stecum sandy loam, 8 to 40 percent slopes
Sn	Stecum sandy loam, 8 to 40 percent slopes, eroded
Ss	Stecum sandy loam, 8 to 40 percent slopes, severely eroded
St	Stony land, Buena Vista materials
Sy	Stony land, Chubbs materials
Tc	Trout Creek clay loam, eroded
Tr	Trout Creek loam
	Wellsville very fine sandy loam

CONVENTIONAL SIGNS



Soil surveyed 1957-58 by John Retzer, Dave Harris, Charles Fox, and J. Nishimura, U. S. Forest Service.
Correlation by Arvad J. Cline, Soil Conservation Service.

Soil map constructed 1959 by Cartographic Division, Soil Conservation Service, USDA, from 1956 aerial photographs. Controlled mosaic based on Colorado plane coordinate system, central zone, Lambert conformal conic projection, 1927 North American datum.

This is one of a set of maps prepared by the Soil Conservation Service and Forest Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1956.

TROUT CREEK WATERSHED, COLORADO

0 ½ Mile

Scale 1:12000

0 2500 Feet

(Joins sheet 2) | (Joins sheet 3)

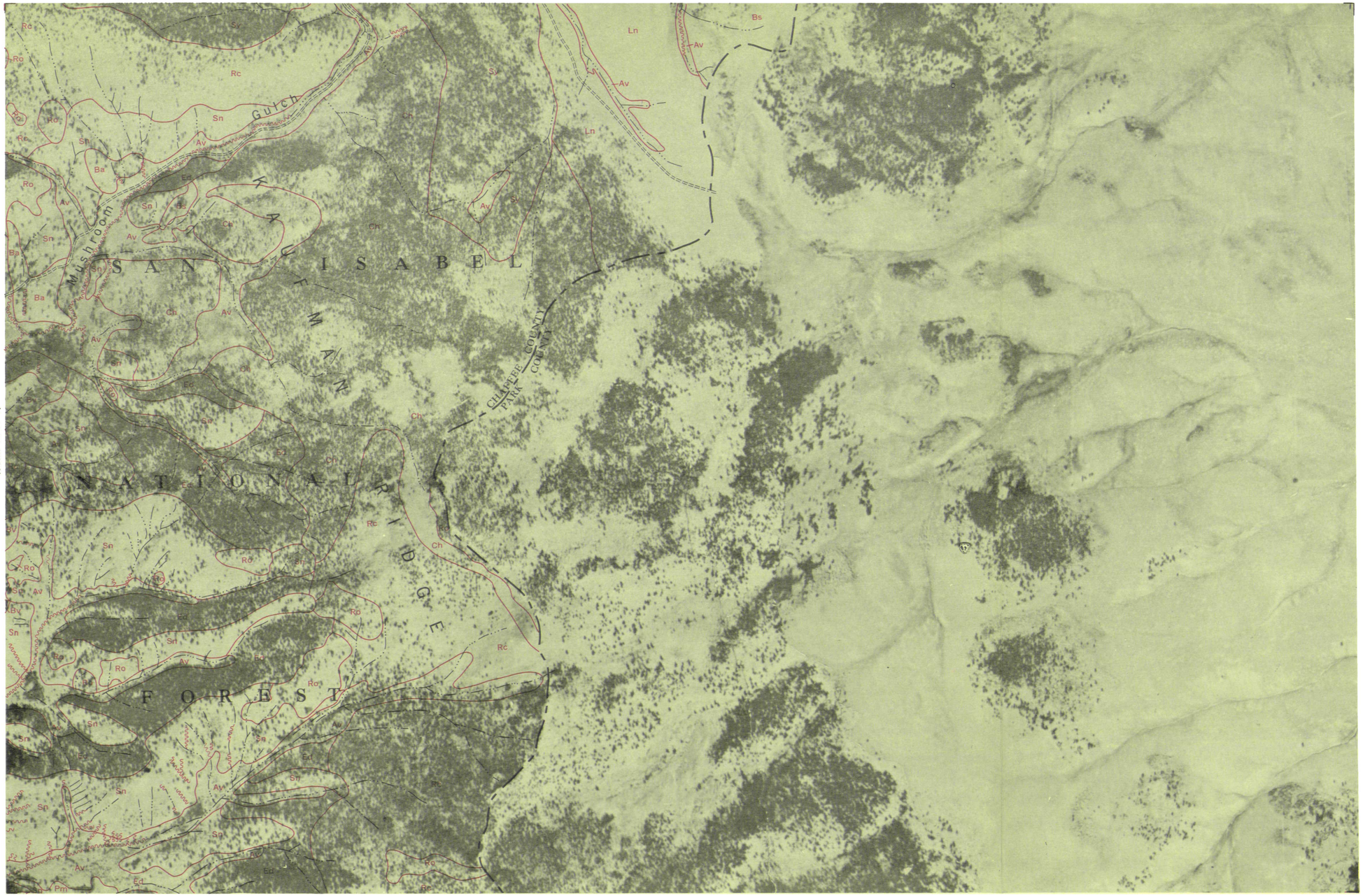
N

1

(Joins sheet 6)

10

N



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(Joins sheet 14)

TROUT CREEK WATERSHED COLORADO

Scale 1:12000

½ Mile 0 2500 Feet

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

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(Joins sheet 12)

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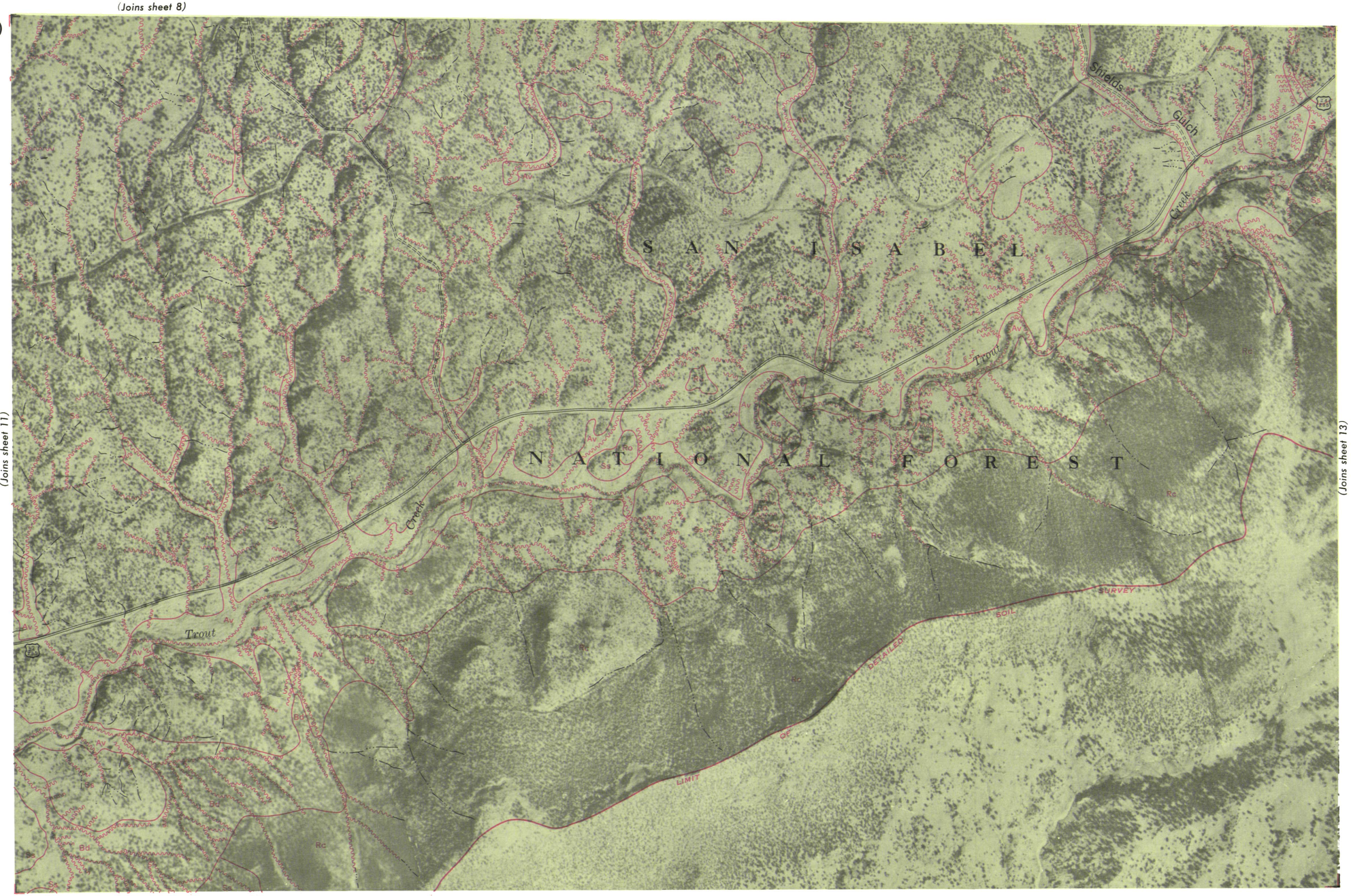

TROUT CREEK WATERSHED, COLORADO

Scale 1:12000

½ Mile 0 2500 Feet

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

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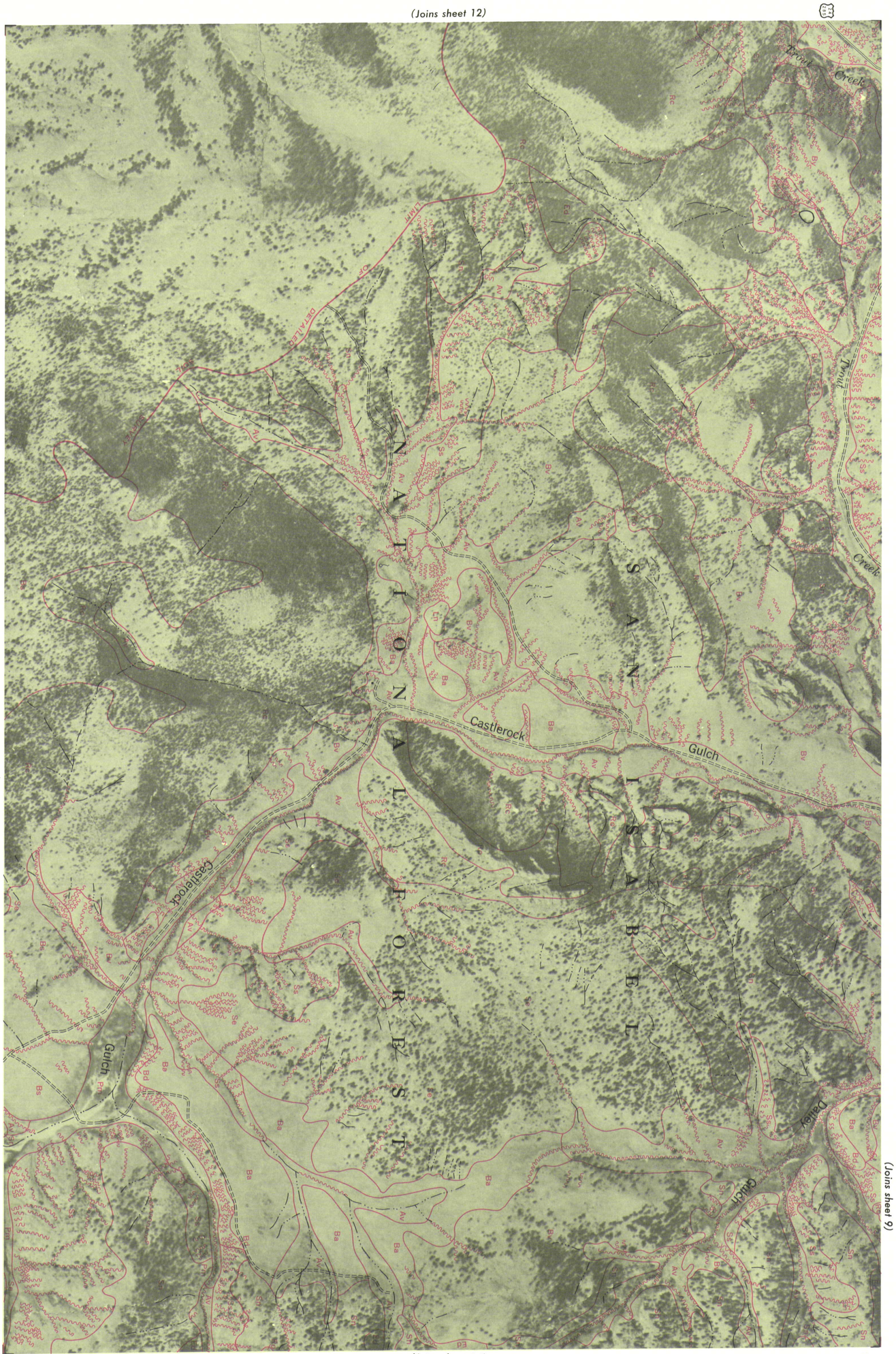

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14

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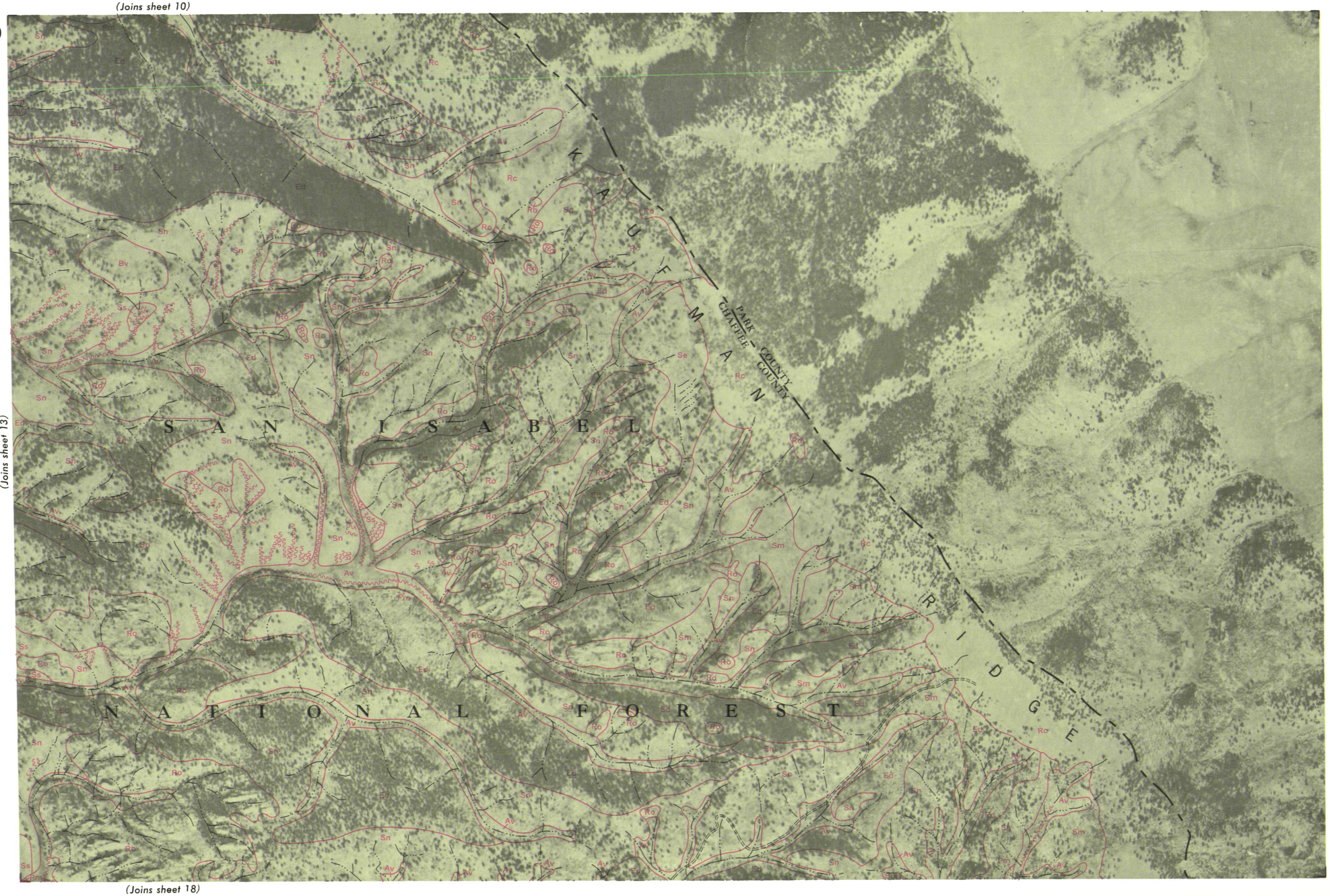

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TROUT CREEK WATERSHED, COLORADO

½ Mile Scale 1:12000

0 0 2500 Feet

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

(Joins sheet 16)

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N

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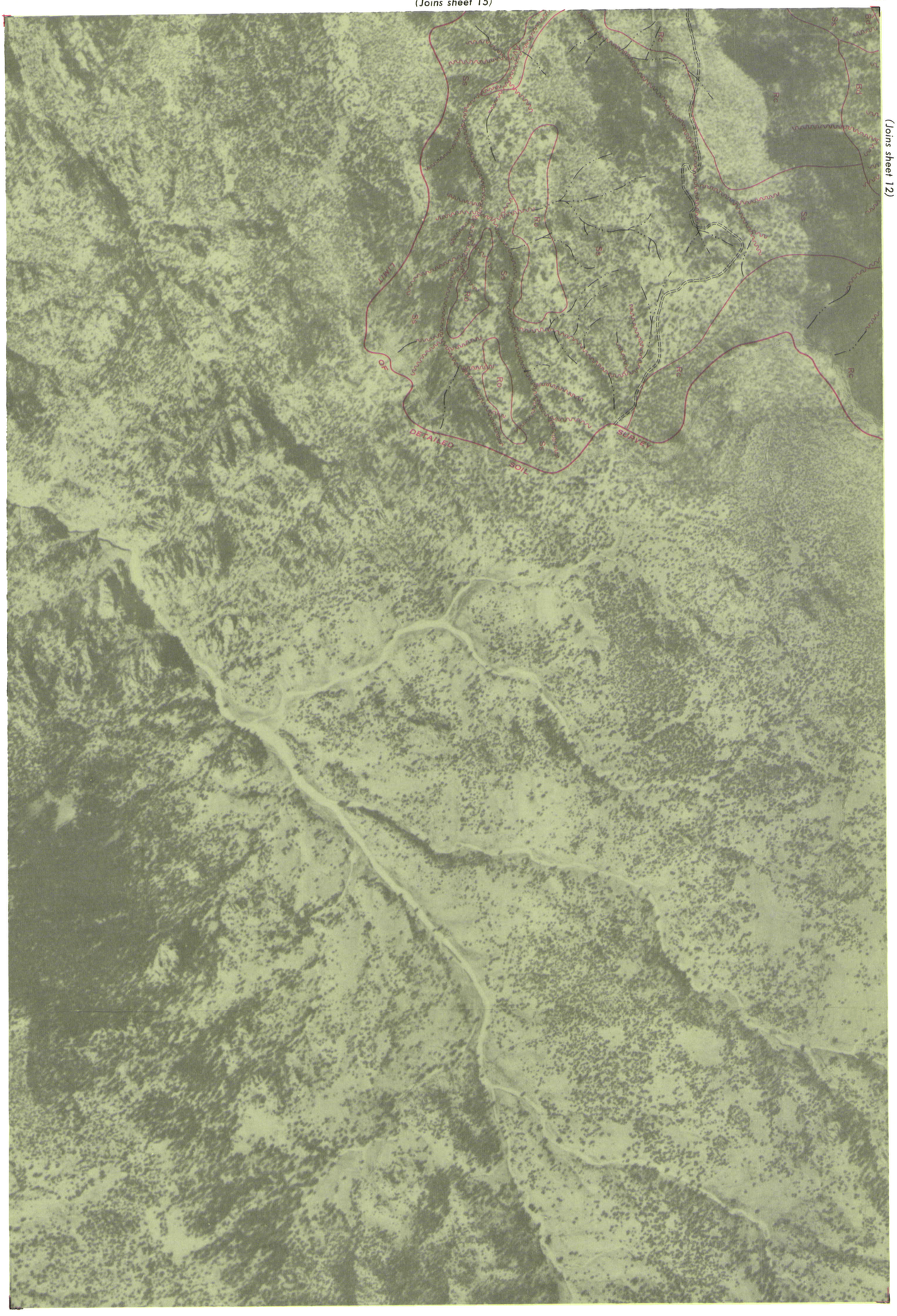

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

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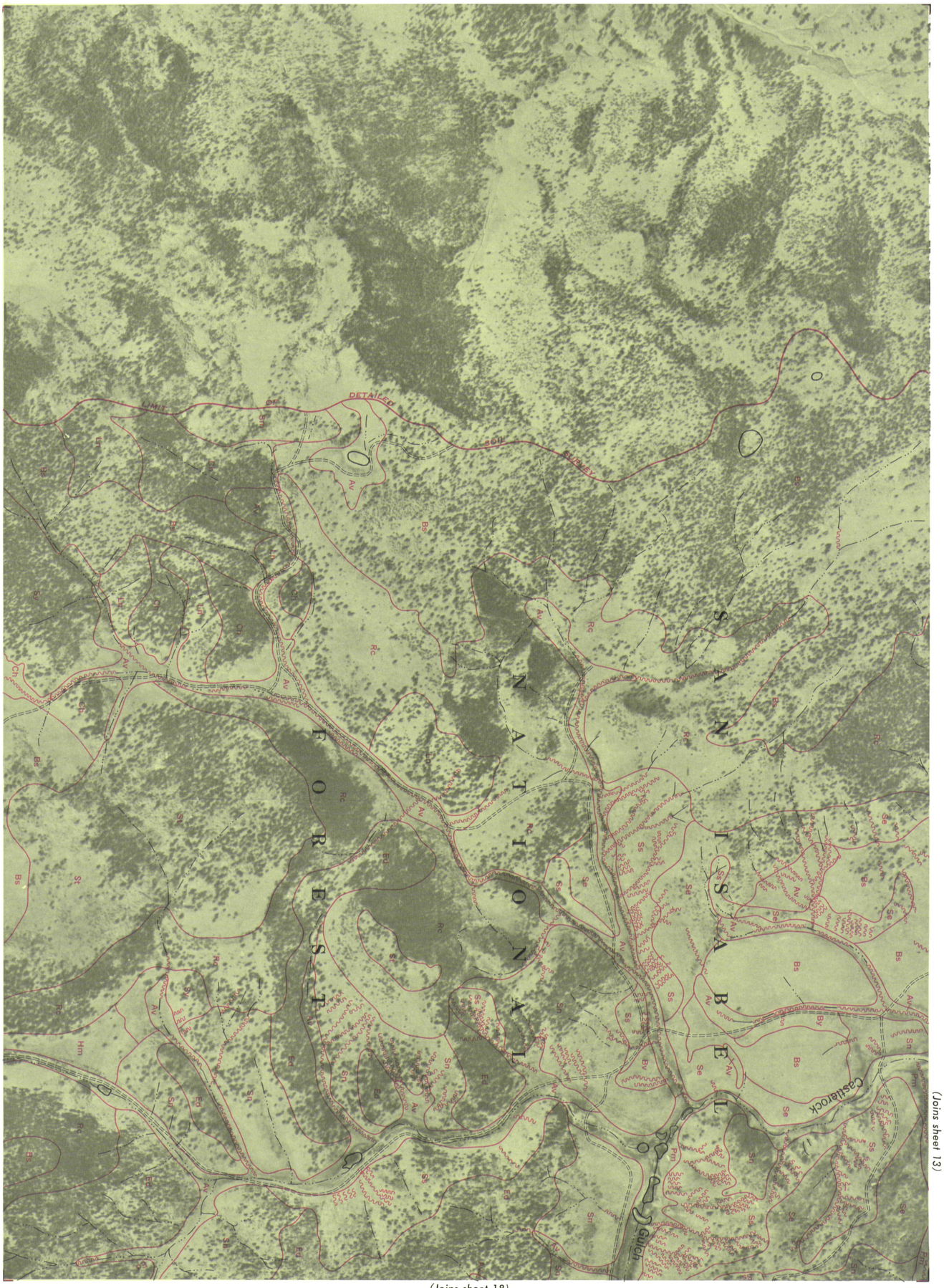
TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet



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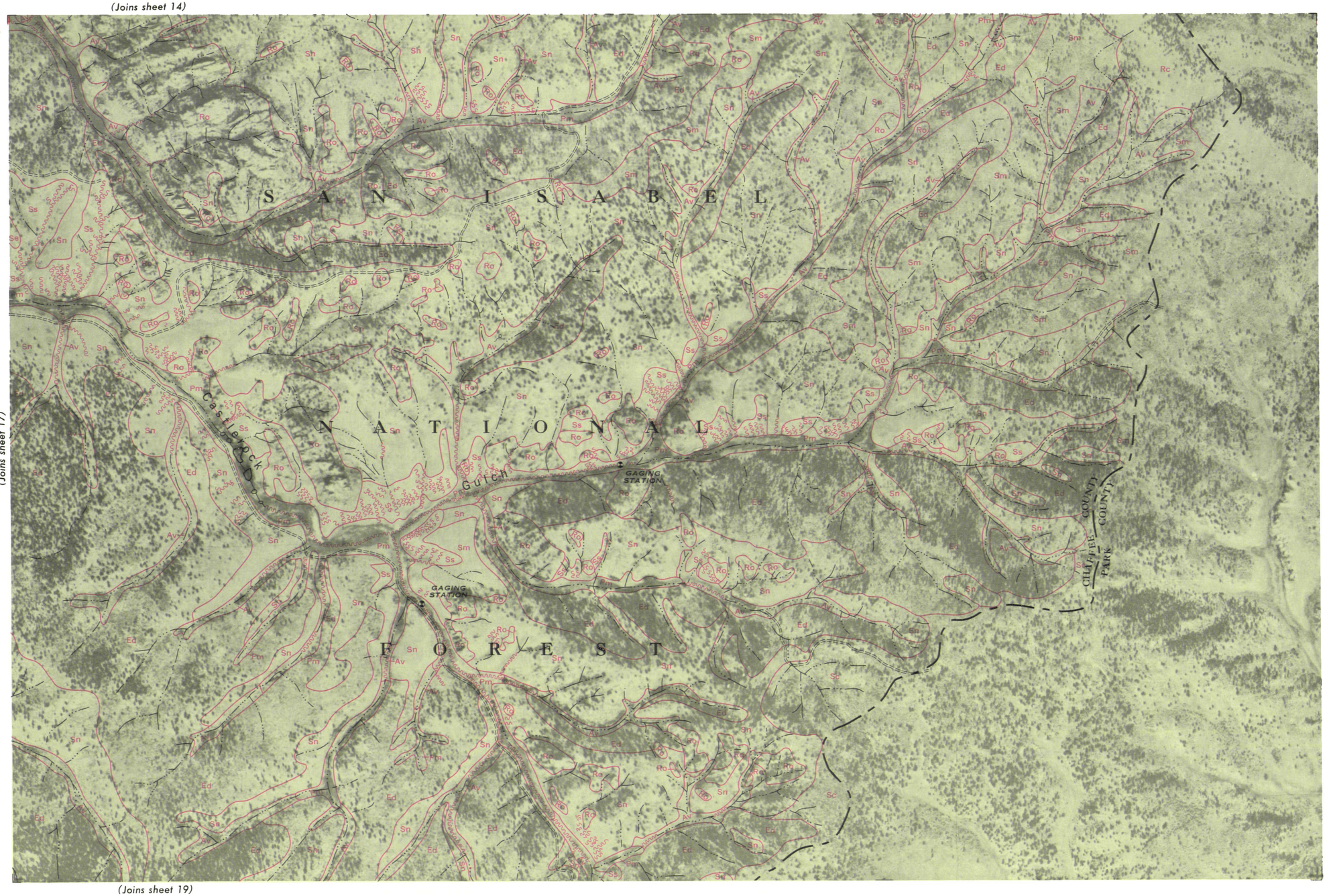
18

N



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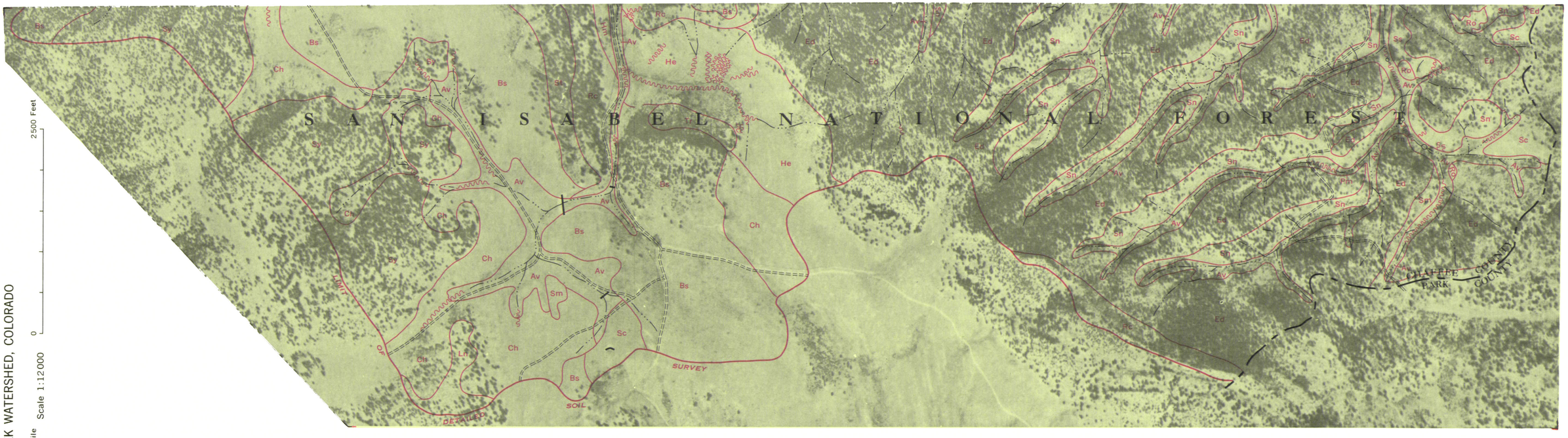
TROUT CREEK WATERSHED, COLORADO

Scale 1:12000

0 ½ Mile

0 2500 Feet

(Joins sheet 17) | (Joins sheet 18)



TROUT CREEK WATERSHED, COLORADO

Scale 1:12000

0 ½ Mile

0 2500 Feet

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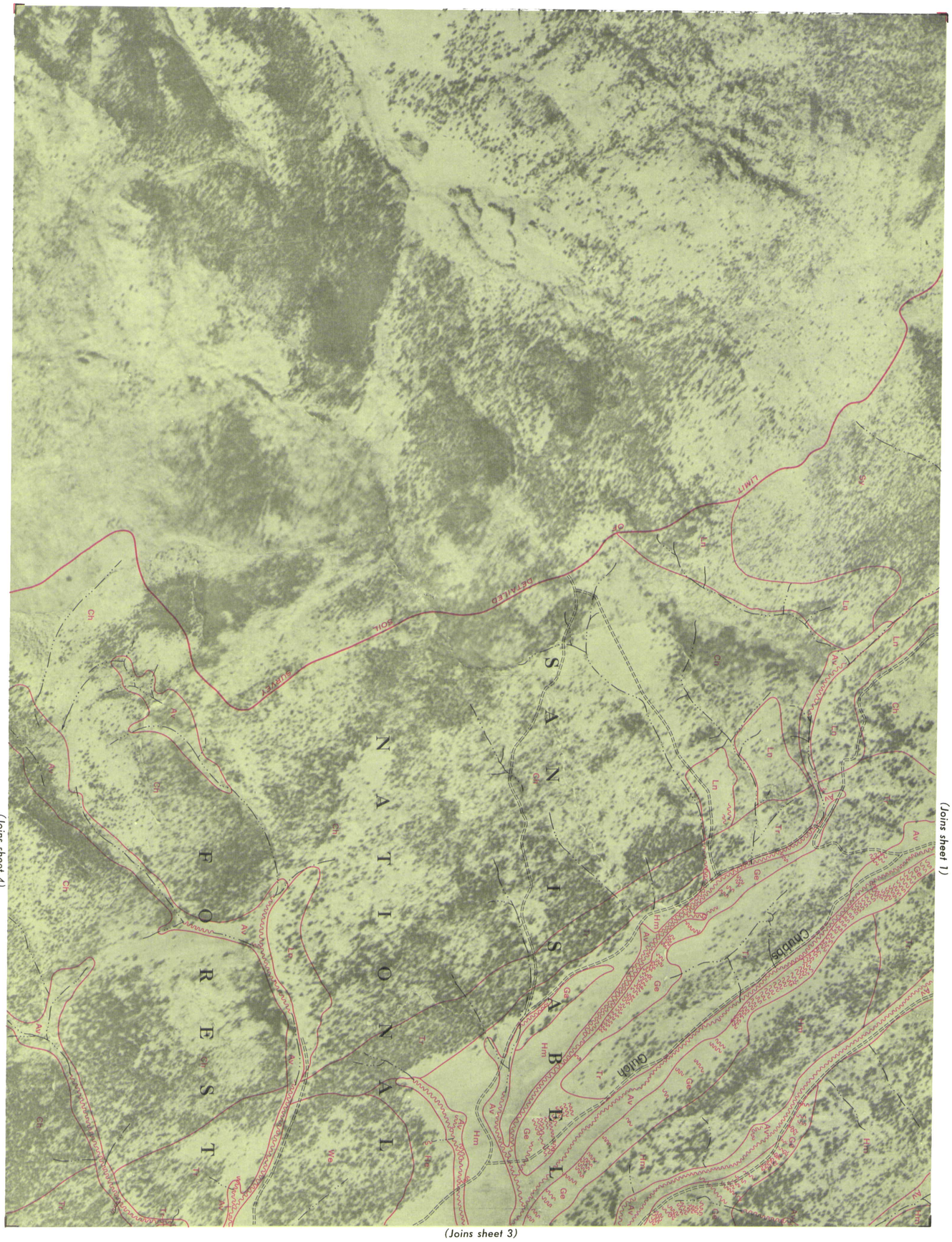
2



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(Joins sheet 1)

(Joins sheet 3)

TROUT CREEK WATERSHED, COLORADO

0 ½ Mile

Scale 1:12000

0 2500 Feet

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

(Joins sheet 2)

(Joins sheet 1)

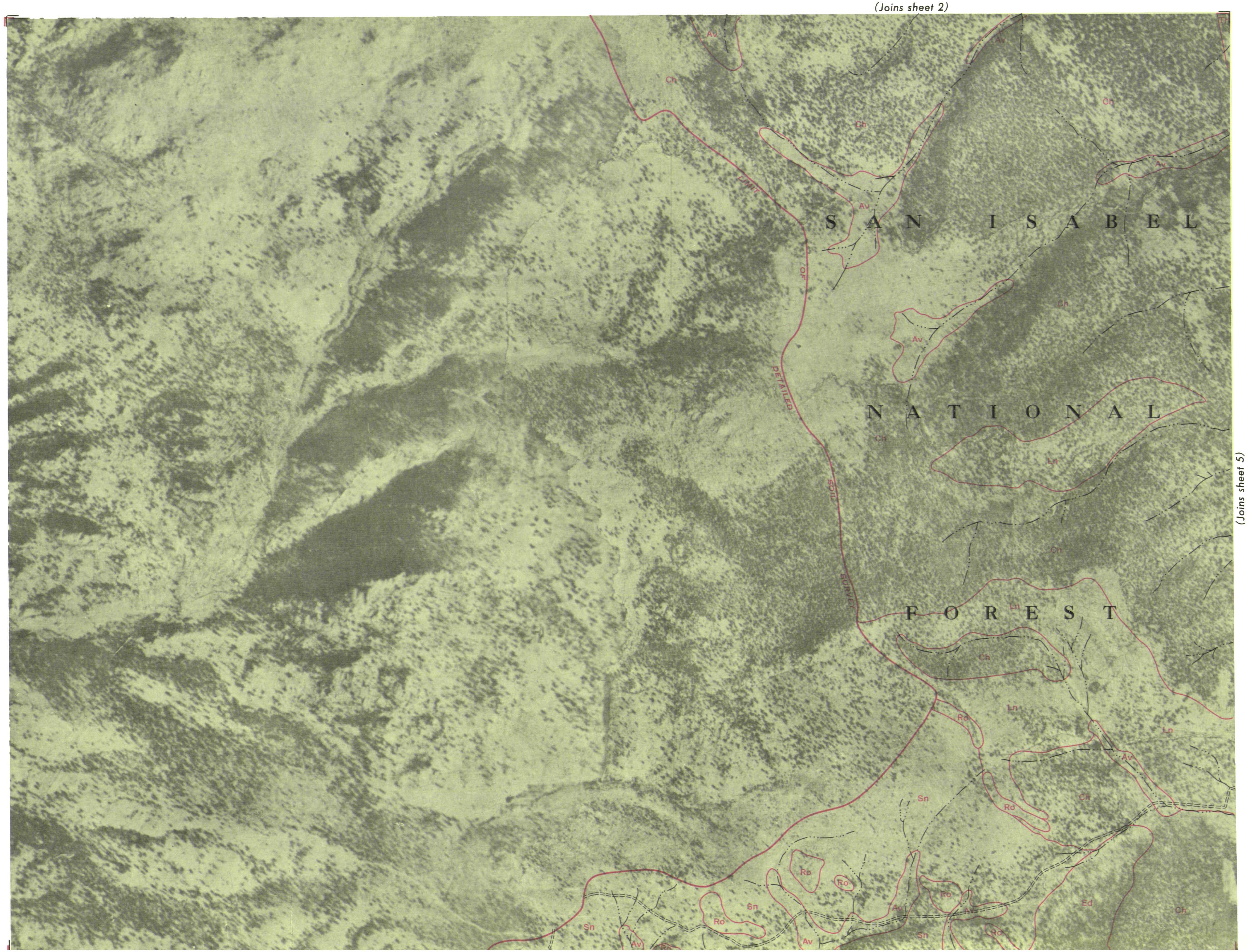
(Joins sheet 5)

N

(4)

N

(Joins sheet 2)



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TROUT CREEK WATERSHED, COLORADO

Scale 1:12000

½ Mile

2500 Feet

0

0

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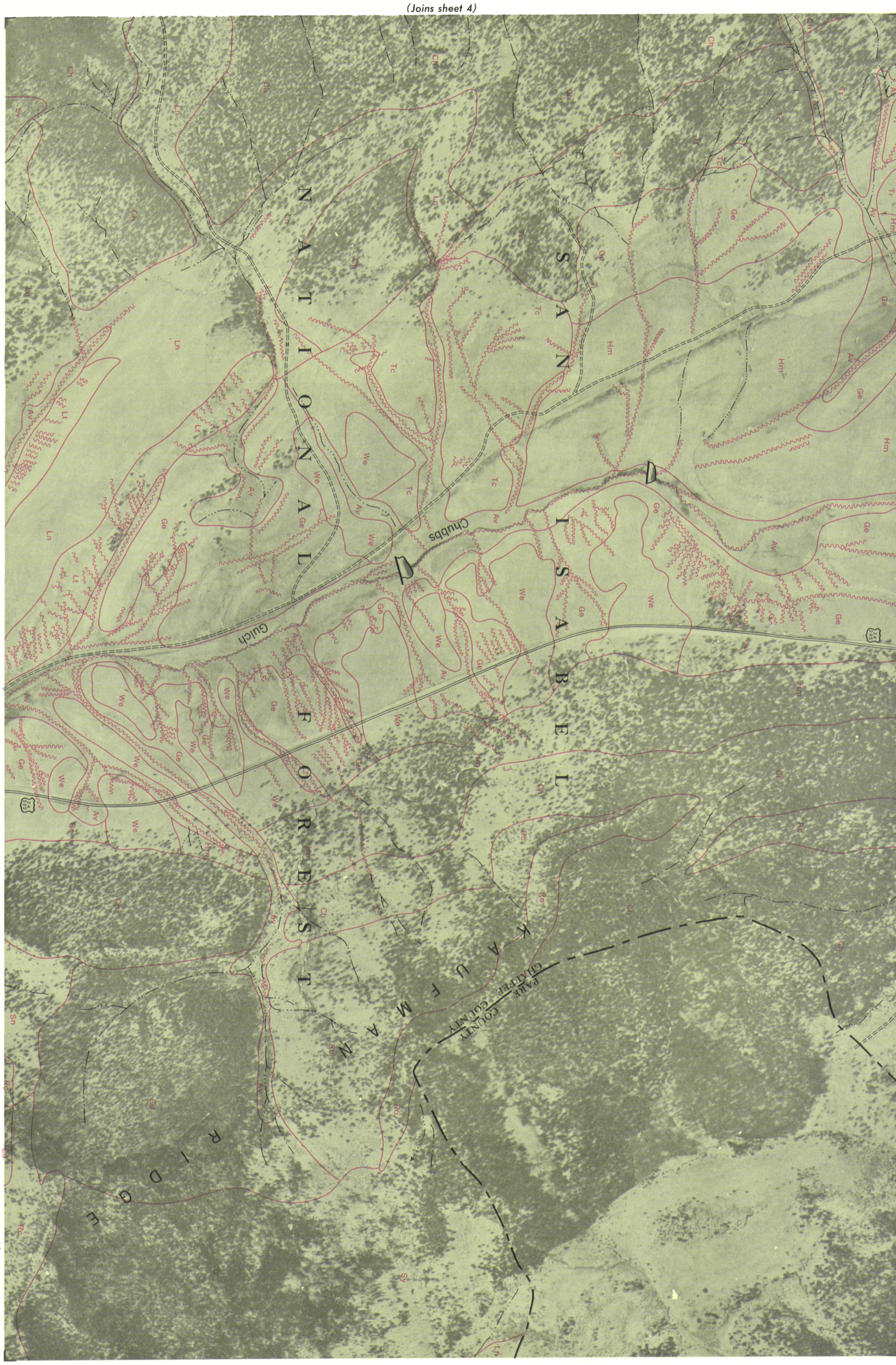
TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

(Joins sheet 4)



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(Joins sheet 6)

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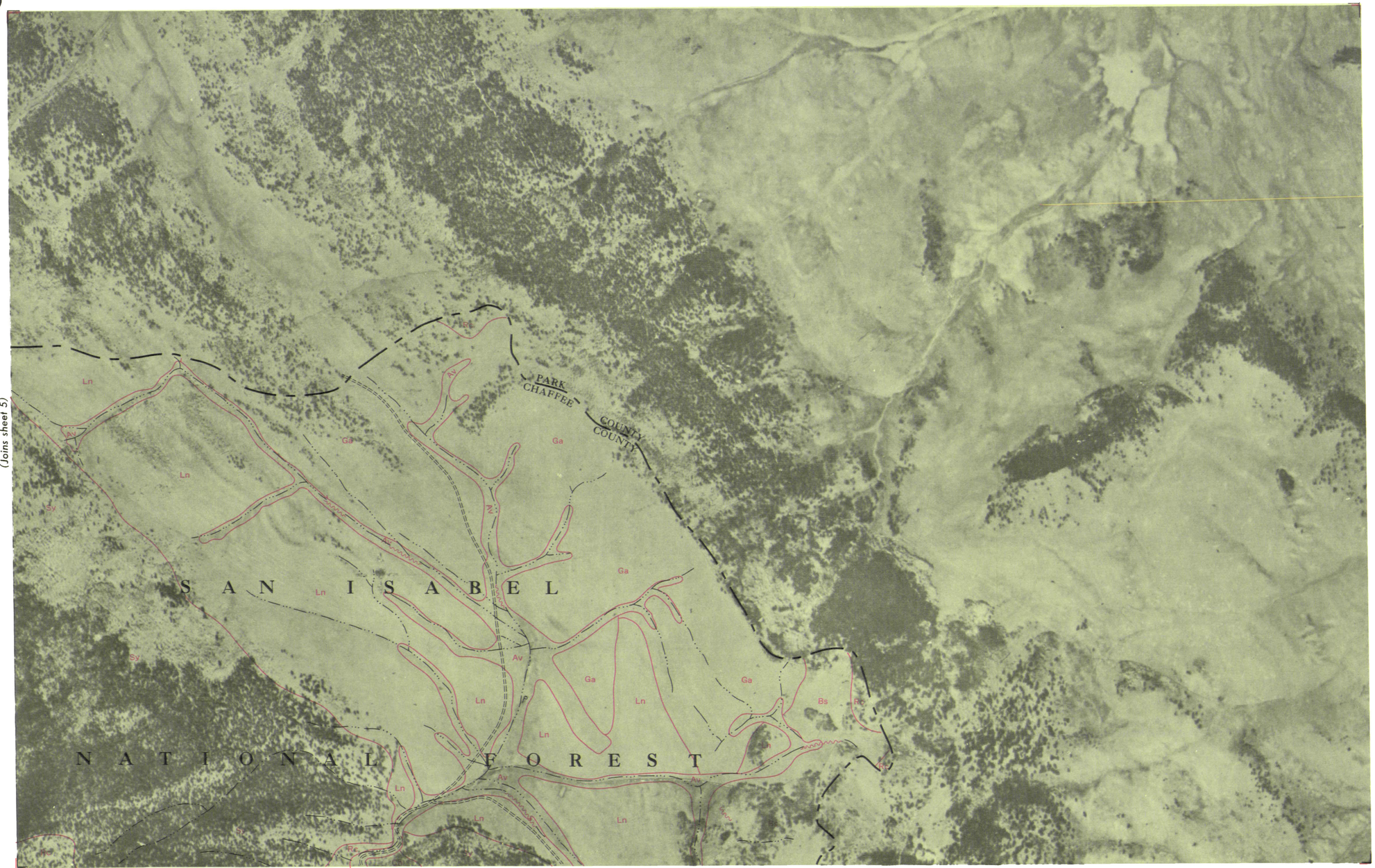

TROUT CREEK WATERSHED, COLORADO

Scale 1:12000

½Mile 0 2500 Feet

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TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

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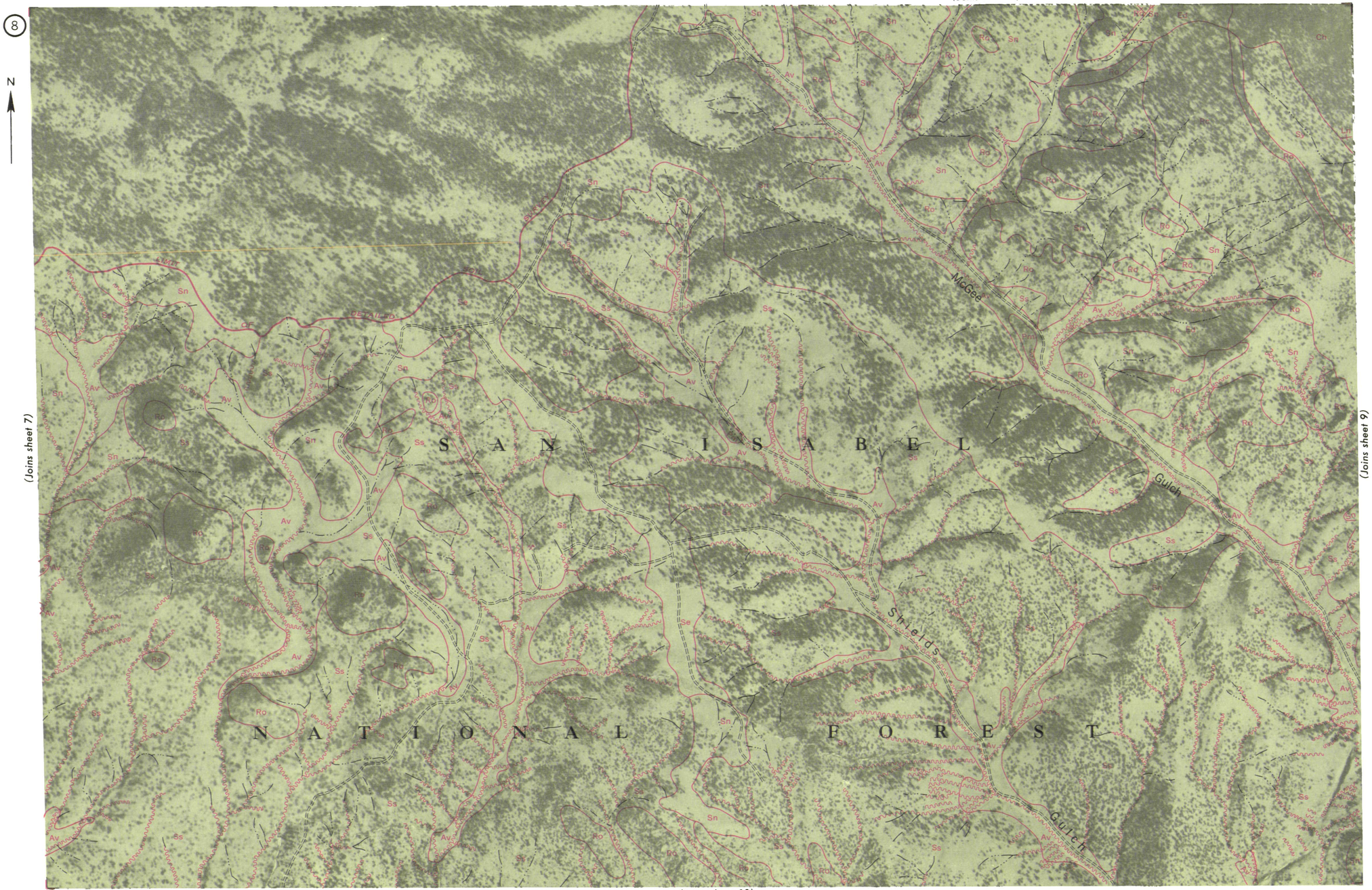
N



TROUT CREEK WATERSHED, COLORADO

½ Mile Scale 1:12000

0 2500 Feet

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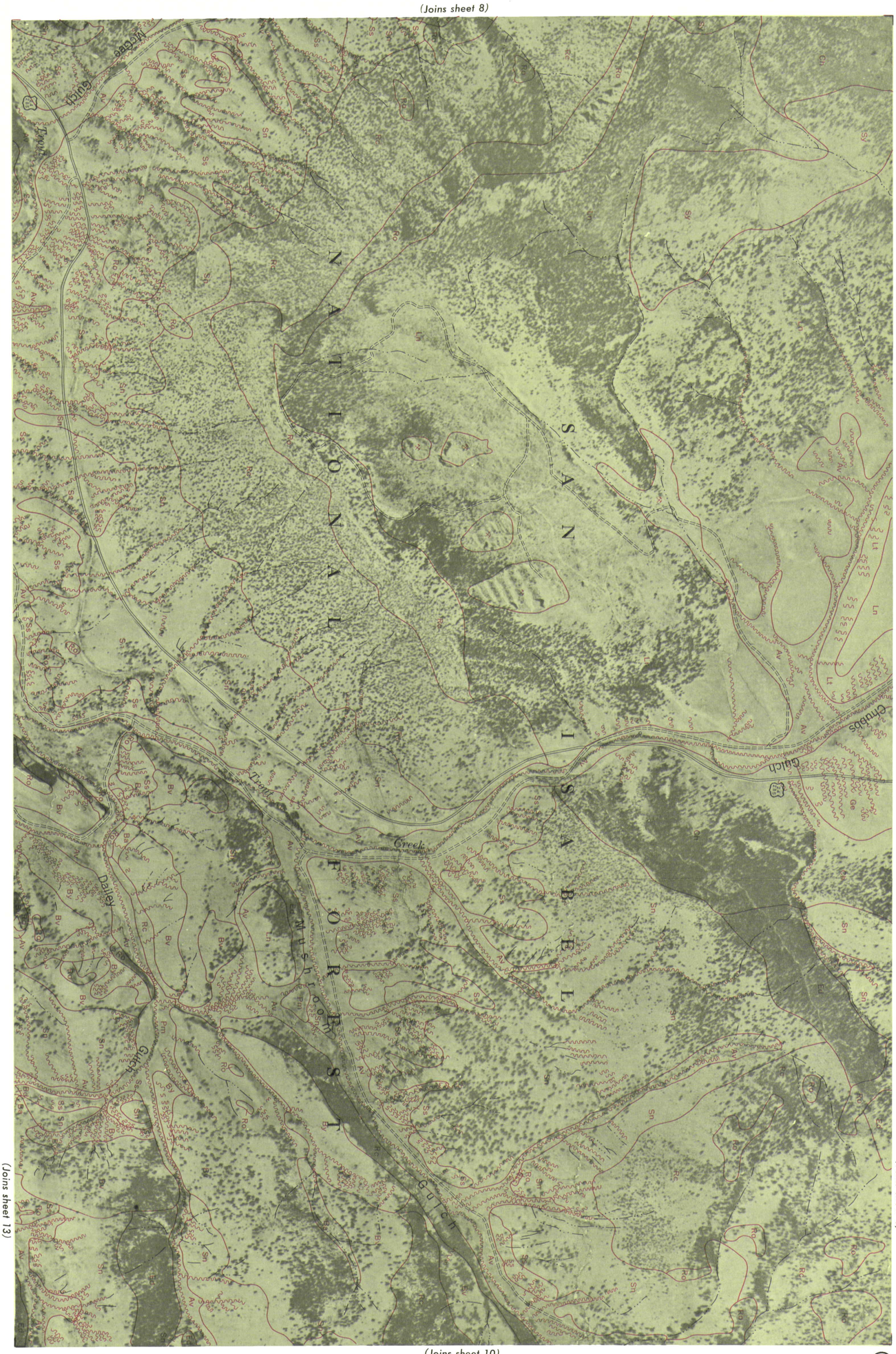
TROUT CREEK WATERSHED, COLORADO

0 ½ Mile Scale 1:12000 0 2500 Feet

(Joins sheet 8)



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